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SERIE: FISKERI · BIND IX

NR. 3. Å. VEDEL TÅNING: FLUCTUATIONS IN THE STOCK OF COD IN ICELANDIC WATERS.

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1931

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FLUCTUATIONS IN THE STOCK OF COD IN ICELANDIC WATERS

BY

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Introduction.

The present work has been carried out on behalf of "Kommissionen for Danmarks Fiskeri- og Havundersøgelser" in order to throw light on the changes which have taken place within the cod stock in Icelandic waters during recent years. It is the beginning of a continuous investigation in those waters with the aim in view of being able, at some time in the future, to predict with certainty the coming of good or bad fishing years. The work was begun on Professor JOHS. SCHMIDT's initiative and I would use this occasion to thank Professor SCHMIDT for handing over these investigations to my care. I have also to thank Mag. ÁRNI FRIÐRIKSSON for his assistance with the major part of the determinations of the number of year-rings in the otoliths; a number of the calculations were also carried out by Mr. FRIÐRIKSSON and by Miss E. HANSEN, who has rendered further help in various ways. I am very grateful for the assistance they gave me.

During the collection of the material I have received valuable help from various people at Iceland, not only from the Icelandic Government and its officers in different parts of the country, even private persons have everywhere, when desired, extended a helping hand. Among these must be specially mentioned the ordinary fishermen who have everywhere evinced great interest in the work. The Danish inspection ships at Iceland and the Icelandic guard ships have been helpful in various ways. The chairman of "Fiskifjelag Íslands", KRISTJÁN BERGSSON, and Dr. BJARNI SÆMUNDSSON have supported our work in many directions. Of manual helpers in the collections I would specially mention the late ÓLAFUR MAGNUSSON and ARI ÞORGILSSON on the Westmanna Islands, and KRISTJÁN KRISTJÁNSSON of Reykjavik who accompanied me to several localities and took part in the work with the greatest interest.

The material of the earliest age-groups of cod, referred to in Section II p. 33, was collected by the research-vessel "Dana"; the age-analyses of this material were made chiefly by Mag. ÁRNI FRIÐRIKSSON, also by Mag. A. BRUUN and myself. A couple of samples of cod, collected in 1930 and mentioned on pp. 17 and 32, were kindly placed at our disposal by Dr. BJARNI SÆMUNDSSON of Reykjavik.

In the fisheries investigations of all countries the continuous study of the fluctuations in the stock of fish forming the basis of the fishery has become one of the principle subjects of investigation, especially since the war; the endeavour everywhere is to make forecasts of the fishery as definite and accurate as possible. In this field we have had already during a series of years a number of studies from different regions, dealing with some of the economically most important species, for example, herring, plaice, cod, haddock etc. in the waters of North-West Europe. So far as the cod is concerned, we have the well-known Norwegian investigations (of Professor JOHAN HJORT and Mr. OSCAR SUND), but elsewhere until quite recent years no continuous investigations of this species have been made.

The Norwegian region produces a large part of all the cod landed in North Europe, but in the course of the last few years the Icelandic region has advanced to an extremely important place among the cod-producing regions, as can be seen very clearly from a consideration of the latest returns of the international fisheries statistics (Bulletin Statistique des pêches maritimes, Vol. XVIII, 1928, Copenhague 1930). These statistics show, that in the year 1928 the total quantity of cod landed in European countries amounted to 923,433 tons, and of this quantity no less than 364,271 tons were taken in the Icelandic region (177,328 tons by Iceland itself). The importance of the Icelandic stock of cod is thus so considerable, that the study of its changes from year to year will be of general interest.

There are at present three known ways of proceeding to obtain an estimate of the quantity of cod of the different year-classes present in the sea at a given period:

1. a quantitative investigation of the occurrence of postlarvae;
2. an investigation of the quantity of growing cod in the fjords, bays and on the banks — especially of the age-groups I—III;
3. a study of the age-composition of the fish taken during the fishery.

1. It has not yet been proved, that a quantitative study of the occurrence of the fry of the cod is practicable in the extensive Icelandic region; the expense of a yearly investigation would be very considerable. The occurrence of the cod fry in Icelandic waters is dealt with by Schmidt (1909).

2. The Danish research vessels, which have been making collections regarding the stock of fish in the Icelandic waters for about 25 years, have been able by means of eel hand seine, trawl and other apparatus to procure a material which throws light on the changes in the stock of the youngest, 2 to 3 age-groups of cod. The material collected in the years 1924—27 will be discussed briefly later (Section II, p. 33) as it deals to some extent with the period we are concerned with here. This material has been considered already in a couple of smaller papers by Schmidt (1926) and Friðriksson (1929). Like the foregoing however this method of investigation would require extensive work at Iceland every year by a research vessel.

3. The third method of studying the changes in the stock, by examination of the fishermen's catches, was introduced for these waters by Professor Johs. Schmidt in 1928 and continued in the following years. This method is specially applicable to the conditions at Iceland, where the youngest age-groups fished keep as far as we know mainly to the north-west, north and east coasts, from which as they approach maturity they migrate towards the large spawning places on the south and west coasts; here we find the largest cod fishery at Iceland, this fishery of the spawning cod amounting to about two-thirds of the total catch of cod at Iceland.

As the codling fishery at Iceland begins with the III—IV group whilst it is not until the cod reach the VIII group that they spawn in large quantity on the west and south coast, this means that about 4 years elapse before a special year-class on which the fishery has commenced fishing proceeds to the spawning places and principal fishing grounds. Hence during these 4 years we should be able to some extent to foretell the importance of the group in the fishery, if, that is to say, the hydrographical or other conditions at one or other period during the growth of the group do not place hindrances in the way of a representative collection in the commercial catches of codling. It would always be of great assistance, of course, if the research vessels could also provide an estimate of the quantitative occurrence from year to year of the postlarvae and the 3 earliest age-groups in the fjords, bays etc.

Nevertheless, even if we do our utmost to obtain reliable evidence from these sources, there will always remain the possibility that a good year-class does not assemble in due proportions on the spawning grounds. We know as yet too little about the hydrographical and other conditions of importance for the cod at Iceland and whether they are so stable, that one can rely upon finding the good year-class

taking part in the spawning on the known spawning grounds. We must also exclude from consideration here the fact, that the weather conditions may place such hindrances in the way of the fishery that a forecast in some years may be quite worthless.

So far as the fluctuations of the cod are concerned, as indeed of practically all species included under such investigations, we have a number of important questions which call for solution or clearer understanding than has hitherto been arrived at, before we can venture to make forecasts for the fishing industry.

In the first place, as the result of the last 25 years' experience, we may maintain that the age determinations of fish by means of scales or otoliths are on the whole sufficiently trustworthy to form a basis of the study of fluctuations, at least so far as the earlier age-groups are concerned. As support for the results obtained in this way it is of importance also to have an extensive material of measurements. In some cases and for certain regions it may be defensible to attach chief importance to the measurements and this would not make the results less certain, so far as the younger age-groups are concerned. Nevertheless, if the material, as is often the case for the cod, contains a large number of fish of medium or greater age, one may consider that an age analysis of 3—400 specimens will afford indispensable assistance and definiteness to the judgment of the measurement curves, although it may contain some uncertainty with regard to the age determinations of the older specimens.

At every stage in the whole series of presuppositions on which the forecasts are based, we must still recognize uncertainty and unsolved problems, and one cannot too strongly emphasize the fact, that contributions towards reduction of the number of errors bound up with the results are of the utmost value if the study of the fluctuations is to become the useful instrument expected by the fishing industry.

With regard to the measurement and age curves obtained from the present investigation it may be said at once, that the following questions can only be partially answered in a satisfactory manner.

1. Are the measurement curves, which are based on 3—7000 specimens, representative of the sizes of fish occurring on the fishing banks at the time of collection? The different apparatus used at Iceland — hand-lines, long-lines, set nets and trawl — give naturally each a selection and the measurement curves are consequently not fully representative for any of the places. It may be noted especially, that an extensive material from trawlers working on distant grounds is desirable. A more exact study and comparison of the curves derived from the data of fish caught by trawl, long-line, hand-line and set nets, should be undertaken in these waters.

2. Are the measurement curves (and age samples) representative for the whole season? The curves have been derived from measurements over a short space of time, as far as possible at the height of fishing. Probably they may be taken to cover to some extent the curves that the total quantity of cod for the whole season would give, but there is here nevertheless a source of error no less great than that in the previous rubric. The measurement curves (and age samples) must be taken simply to represent the momentary condition, and it will be necessary, at least throughout some years, to obtain material collected during the whole season; this would then form a basis for considering at what periods measurements should be undertaken to make the curves representative of the whole season. It would also be necessary to procure more detailled fisheries statistics than at present, especially with regard to the intensity of fishing during the season, in order to give a broader basis to the investigation.

3. Are the age analyses representative of the stock of fish landed at the time when the sample was taken? In other words, assuming that the measurement curve is representative, is the curve obtained from the age analysed material identical with the measurement curve? During the fishery we have endeavoured to take samples at suitable intervals, so that the curve from the age analyses might as far as possible be identical with the measurement curve. A comparison of the curves seems to confirm this; for the

years investigated, 1928—30, the two curves are very nearly identical (most so in 1928 and 1930, hardly so satisfactorily in 1929).

Even if the measurement curve and the curve derived from the age analysed material agree to some extent, yet a more detailled examination of the curves may be useful, as one may learn which age-groups are either too strongly or too weakly represented in the age analysed material. Fig. 1 containing the material available from the three years and from the various places at Iceland, gives a summary of the observed and calculated distribution of the age-groups, taking first the age analyses and then the measurement material combined with the age analyses as basis. The calculations were made by Mag. Árni Friðriksson; the grouping in the age analyses being used to calculate the proportion of the measurement-material for each 5 cm. group and for each age-group. In the accompanying example the number derived from the age analyses is printed in heavy type, the calculated number in weaker type.

Table 1.

5 cm. classes	Age-groups								No. determined by age	No. measured
	VI		VII		VIII		> VIII			
:	:	:	:	:	:	:	:	:	:	:
80—84	..	..	**3**	45	**95**	1441	**4**	61	**102**	1547
75—79	**3**	51	**4**	68	**102**	1729	**1**	17	**110**	1865
:	:	:	:	:	:	:	:	:	:	:
Total	**21**	568	**23**	428	**329**	5462	**22**	399	**407**	7438
%	**5.2**	7.6	**5.7**	5.8	**80.8**	73.4	**5.4**	5.4	**100**	100

It will be seen from the curves, Fig. 1, that the avaiable material when analysed according to age indicates on the whole, that a rather correct estimate of the proportions of the age-groups present at a given time is possible from a combined consideration of the measurements and age analyses.

4. Do the age analyses and measurement curves give an exact indication of the quantity of fish in the sea belonging to the separate age-groups? This question must be answered in the negative simply for the reason, that the fishing intensity is not sufficiently well known and cannot be ascertained from the available statistics. Further, we know that all investigations based on the ability of the practical fishing to give a representative picture of the whole stock present in the sea, whatever the species, are in most cases complicated by more or less considerable errors. Under the preceding three points various weaknesses have also been shown in the material used and the curves based on it; we are thus obliged to maintain, that essential progress can only be attained by seeking to remove these weaknesses in the material as much as possible, and by obtaining reliable information on the intensity of fishing. Until this has been attained, the analyses can only yield cautious statements made with all reserve regarding the actual quantity of the separate year-classes in the sea.

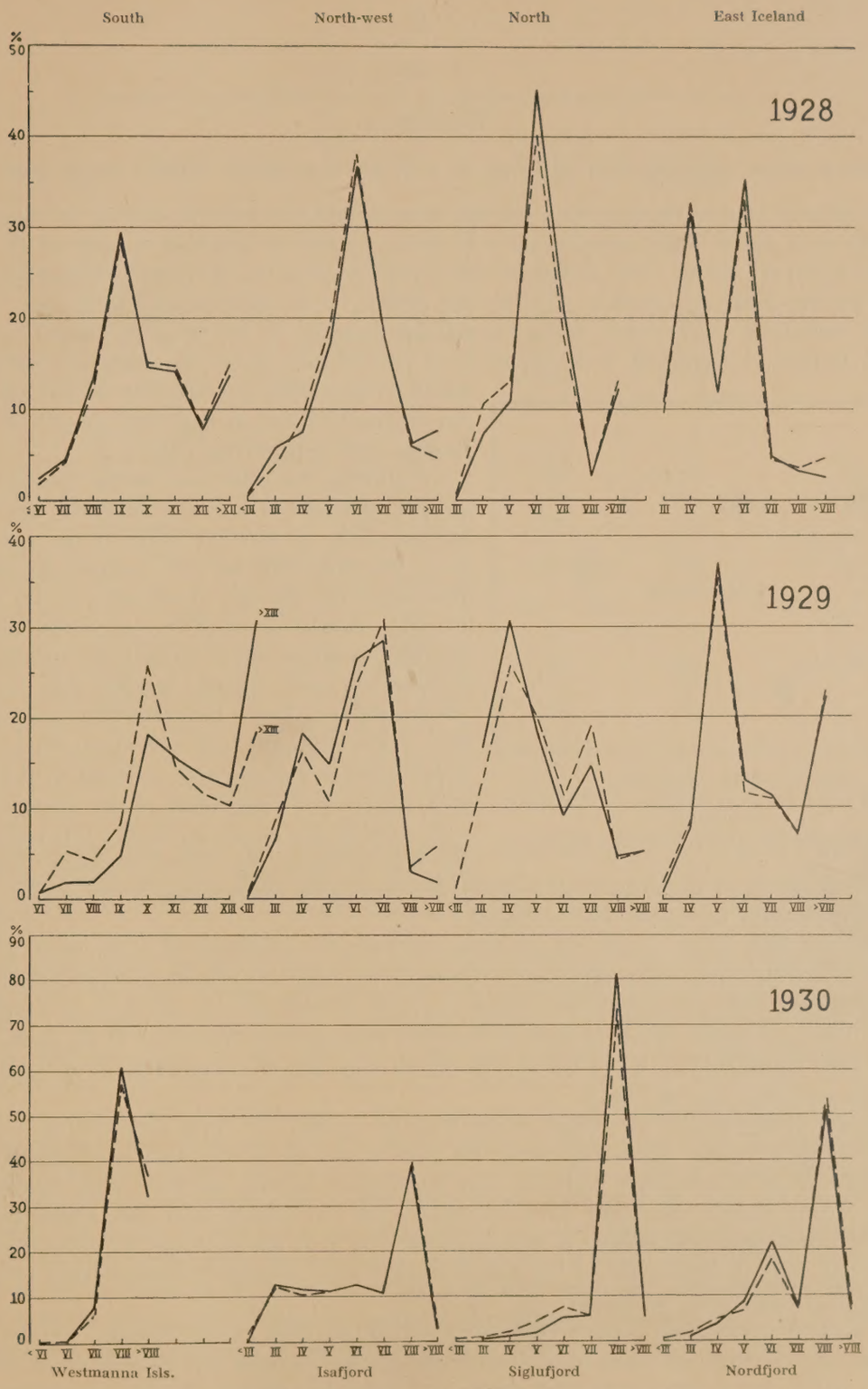

Fig. 1. Percentage of age-groups. — ——— Curve representing age analysed material.
——— Curve constructed according to measurements material and age analyses.
(The curve from North-west Iceland 1929 represents May material only).

Section I.

Material from commercial catches of cod for the years 1928, 1929 and 1930.

The original plan for the collections was indicated by Professor JOHS. SCHMIDT in the following terms:

"The main object of the investigations is to obtain material to enable us to judge of the fluctuations in the stock of cod at Iceland. — The endeavour will be made to attain this (a) partly by collection of measurements of cod, (b) partly by collection of scales and otoliths for the determination of the age.

The collections will be made during the cod fishery season at the following places: 1. Westmanna Islands, 2. Isafjord, 3. Siglufjord, 4. Nordfjord. — At each of these places the endeavour will be made to obtain at least 2000 measurements of cod (distinguishing sex if possible) and at least 200 samples of scales and otoliths with appertaining data."

Fig. 2. Localities of material.
1. Westmanna Isls. 2. Isafjord. 3. Siglufjord. 4. Nordfjord.
a, b and c localities for supplementary samples.

During the collections at the various localities it proved desirable to increase somewhat the number of measurements as also the material for age determinations; the totals collected and analysed are shown in the following table; the date of collection is also indicated in the table. A more detailled account of the material from the different places will be found in the introduction to the treatment of each separate locality. The Chart (Fig. 2) shows the places from which collections were taken in the three years 1928—30. This also shows where a couple of supplementary samples were collected in 1930. Landings of 3—500 or more specimens of the commercial catches were used for the measurement, as a rule each day during the time of stay at the respective places. The measurements were all made to the nearest cm. below[1]; the sexes were distinguished in the greater part of the material; both otoliths and scales were collected.

When possible, curves of the measurements were drawn at intervals of a few days, which helped to show clearly the size composition of the stock; this was of importance in enabling us to select suitable catches for the age analysis. The age samples were taken in groups at intervals of a few days, as a rule about 100 specimens of a catch which seemed to agree as nearly as possible with the picture of the stock already obtained from the measurements. It was not possible in all cases however, due partly to the local conditions, to make the collections on this basis.

The age determinations were made chiefly from the otoliths. On filing a small groove in the centre these could easily be broken across the middle; the cross-section has usually to be ground to give a clearer picture. The otoliths are examined against a dark background and the markings often become clearer if the otoliths are moistened with water, xylol or alcohol. The cod otoliths from these waters permit of age determinations with small uncertainty, at least apparently, up to an age of at least 8 years (in most samples the uncertainty scarcely exceeds 10—15 %; several samples were determined independently by two persons at different times with good agreement).

In a recent publication (Procès-Verbaux, Vol. LXVIII, 1930, p. 12) MICHAEL GRAHAM has stated that the age determinations of SÆMUNDSSON and WINGE for the Icelandic and Faroese waters are uncertain ("probably well to regard with considerable reserve"). I would remark here, that my experience with regard

[1] The average lengths in tables etc. are not corrected by 0.5 in this paper.

Table 2.

Year and Locality	Date	Number of measure-ments	Number of age-deter-minations
1928			
Westmanna Isls.	16-17/IV	2,838	306
Isafjord	4-26/V	4,301	321
Siglufjord	4-16/VI	6,642	309
Nordfjord	28/VI—13/VII	6,050	408
Total...	..	19,831	1,344
1929			
Westmanna Isls.	8/IV—9/V	3,634	403
Isafjord	21/V, 18-28/VI	3,253	548
Siglufjord	31/V, 12-24/VII	4,543	463
Nordfjord	30/IV—18/V	4,190	511
Total...	..	15,620	1,925
1930			
Westmanna Isls.	2-19/IV	3,562	450
Isafjord	30/V—11/VI	5,562	425
Siglufjord	14-25/VI	7,450	407
Nordfjord	30/VI—11/VII	6,422	457
Total...	..	22,996	1,739
Grand Total...	—	58,447	5,008

to the certainty of cod and plaice age determinations from these waters, by comparison with the regions to the south-east, leaves me in no doubt that the percentage of accuracy is considerably higher than in the latter, owing amongst other things to the greater distinctness of the winter rings at Iceland. Especially for the older age-groups the age determinations have a greater certainty than in the south-eastern regions.

Bjarni Sæmundsson has given from all coasts of Iceland valuable information regarding the age and growth of the cod in his work "On the Age and Growth of the Cod (*Gadus callarias* L.) in Icelandic waters", 1923. We find from this that the growth is exceedingly different on the south and west coasts by contrast with the north and east coasts; for the first 8 age-groups the difference in the average size of the separate groups amounts even to 9.1—22.5 cm. (l. c. Table p. 27 and Fig. 3, p. 28).

This exeedingly great difference in growth of cod from the different coasts obliges one to treat curves obtained from measurements with great caution. A direct comparison of measurements from East and West Iceland, for example, made for the purpose of seeing which group or groups may be dominant, can only be utilized with advantage after a close study of the growth of the different age-groups from the two regions. This applies to material of fish up to about 8 years old; after that age (perhaps a little sooner or later for certain parts of the stock) the migrations, so far as we yet know, lead to a fairly general mixing of the cod from all the coasts on the spawning banks to the south and west; after spawning the cod again scatter to the different coasts, hardly reaching exactly the original places where they grew up. Owing to these special conditions it will be necessary in the present work to consider each locality separately.

A. South Iceland. Westmanna Isls.

1. Material and remarks on the material.

The extent of the material from this region for the different years will be seen from Table 2 p. 9. Owing to the uniformity of the samples from here it is scarcely necessary to deal with such large samples as is the case at places, where the catch varies to a much greater degree in regard to small and large cod.

Proportion of sexes. With regard to this point — see Table 33 Section II D, p. 38 — we may note that the collections here were made at a time when the fish were almost all spawning, thus with a small percentage of immature or spent fish; consequently, we meet with the usual condition at typical spawning places, namely, that the females are greatly in the minority. The special conditions during the years investigated, due to the invasion of the spawning places by a very dominant year-class, offer special features, which we can, however, only elucidate in detail after an examination of the ages of the stock.

The fishery at Westmanna Islands is distinctly a spring fishery of spawning cod and begins at the end of January and in February, but the real important fishery only begins in March terminating as a rule at the end of April. Accounts with the fishermen are made up on May 11th, but farther on in May and a little later a few fish, chiefly small, are still caught (cf. Figs. 11—12, p. 39). The fishing is by long line and cod nets; but throughout the season and from year to year the use of these varies according to the best results obtained. For this important fishing region the cod nets are of recent date, being introduced at first on a small scale in 1916, but their use has become very important since then; previously only long lines and hand lines had been used. The fishing begins in January with the long lines, and nets are used from about the middle of March; in 1929, however, more than for several years back, long lines were used throughout the season as well as nets. The nets fishery ends as a rule late in April, the spawning of the cod being over by that time. The nets are set out from motor boats (from about 7—8 to 35 tons with about 90—100 boats in all). The fish are caught mainly in depths between 70 and 120 metres.

In **1928** the greatest fishery took place about the 6th to the 16th of April; at this time up to 200,000 specimens of large cod might be landed in one day on the Westmanna Islands alone. The fish were apparently swimming up in the water, as the long line fishing was not so good; the trawlers had to float their head rope and trawl lightly over the bottom to have a good fishing.

Only the nets material could be dealt with this year at this corner of the island; the average length of the separate samples varied but little from day to day, as the following examples will show:

Table 3.

16/4 — 220 spec.	Average	length	94.2 cm.		20/4 — 328 spec.	Average	length	98.4 cm.	
17/4 — 585 —	—	—	98.3 -		20/4 — 235 —	—	—	97.3 -	
18/4 — 255 —	—	—	98.0 -		26/4 — 273 —	—	—	98.5 -	
19/4 — 338 —	—	—	100.7 -		27/4 — 297 —	—	—	98.6 -	

In **1929** the fishery proceeded as usual with long line to the middle of March, thereafter with net; the latter, however, was less than the previous year's fishery, but was continued into May; the long line fishery was then taken up again, which is not to any extent usual in the month of May.

The extremely large accumulation of spawning cod west of the islands, which normally occurs chiefly in the first three weeks of April, did not take place this year to any prominent extent. The cod seemed to be much more in movement and scattered than usual. They were also thin this year and the liver production small (only abt. 1 barrel from the same number of cod that otherwise gives 3).

As in the previous year the average length did not vary much from sample to sample:

Table 4.

5/4	— 275 spec.	Average	length	95.3 cm.	26/4	— 363 spec.	Average	length	99.9 cm.
9/4	— 262	—	—	95.3 -	27/4	— 334	—	—	99.1 -
11/4	— 454	—	—	96.1 -	27/4	— 384	—	—	100.8 -
22/4	— 392	—	—	97.5 -	28/4	— 265	—	—	98.8 -
26/4	— 225	—	—	99.3 -	28/4	— 277	—	—	98.1 -

In **1930** there was an extremely good fishery; for example, on April 19th no fewer than 210.000 large cod were landed on the Westmanna Islands (from 97 motor boats). The line fishery was continued till about April 10th, and then the nets were chiefly used.

The average length of each sample is given below for comparison with the preceding years; the values are considerably lower than in 1928 and 1929.

Table 5.

Long lines	3/4	— 170 spec.	Average	length	86.6 cm.	Nets	11/4	— 354 spec.	Average	length	92.1 cm.
	4/4	— 216	—	—	86.1 -		12/4	— 444	—	—	92.7 -
	8/4	— 136	—	—	86.2 -		13/4	— 376	—	—	90.7 -
	9/4	— 353	—	—	89.2 -		15/4	— 322	—	—	92.1 -
	10/4	— 442	—	—	88.7 -		16/4	— 323	—	—	93.5 -
							19/4	— 426	—	—	93.5 -

As will be noticed, the cod samples of 1930 came exclusively in the beginning from the long lines, later exclusively from the nets. As the periods for these two methods of fishing overlapped this year at the height of the season, it is noticeable that as might be expected they give a somewhat different size for the fish.

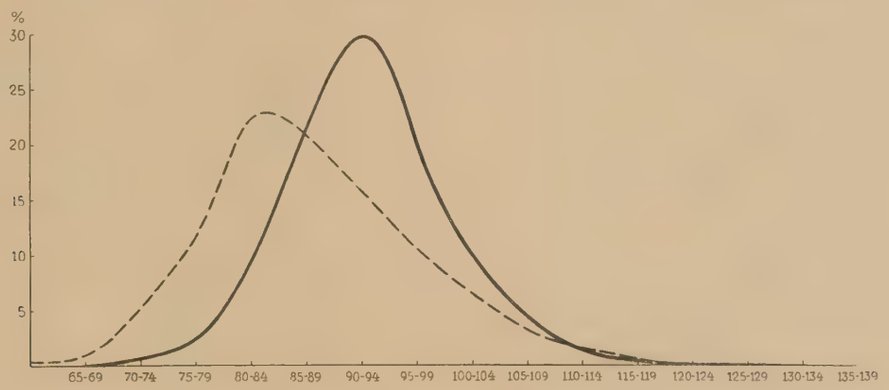

Fig. 3. Length frequency distributions of cod, Westmanna Isls. South Iceland 1930.
– – – – Long lines, April 2nd—10th, 1317 specimens. ——— Nets, April 11th—19th, 2245 specimens.
Length in 5 cm. groups.

This is shown clearly by the curves Fig. 3 indicating the frequencies of the different sizes in the nets and line caught cod. As we shall see later, however, the age composition of the samples taken by line and net is not so very different (p. 15).

2. Measurements and Age-composition.

a. Fluctuations.

Fig. 4, p. 12 represents the composition of the cod stock fished on this part of the coast in the years 1928—30. The measurements are given in the Tables p. 42, the results of the age analyses in Tables 7—9, p. 16.

The uppermost curve in Fig. 4 gives the length frequency distribution of the cod measured[1], below

[1] The figure for each variant is calculated in thousandths of the whole material; in future investigations of this kind however it will probably be sufficient to give the composition in 5 cm. groups; the tables p. 42 give a summary of the material expressed in this way.

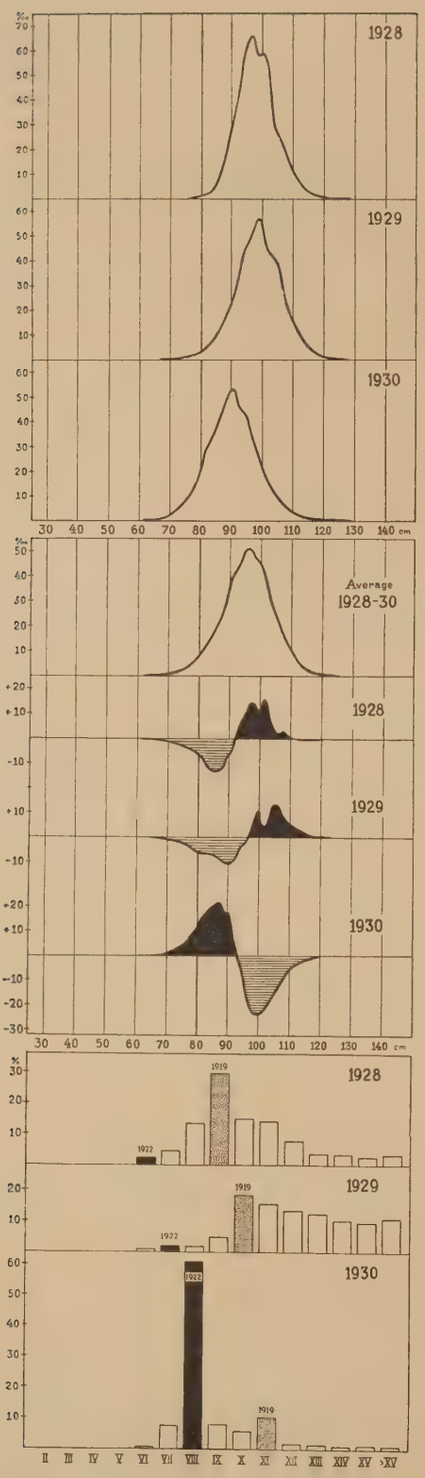

Fig. 4. South Iceland (Westmanna Isls.).

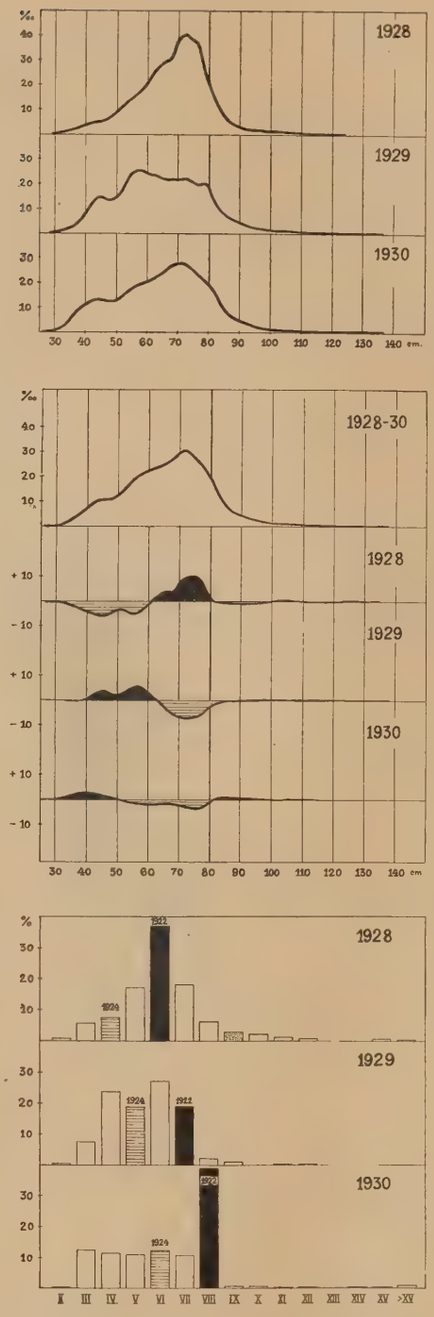

Fig. 5. North-west Iceland (Isafjord).

Fig. 4—7. Diagrams illustrating: a) the length frequency distributions of cod 1928—1930, b) the deviations of the length frequency distributions of each year from the average of the three years, and c) the results of the age determinations.

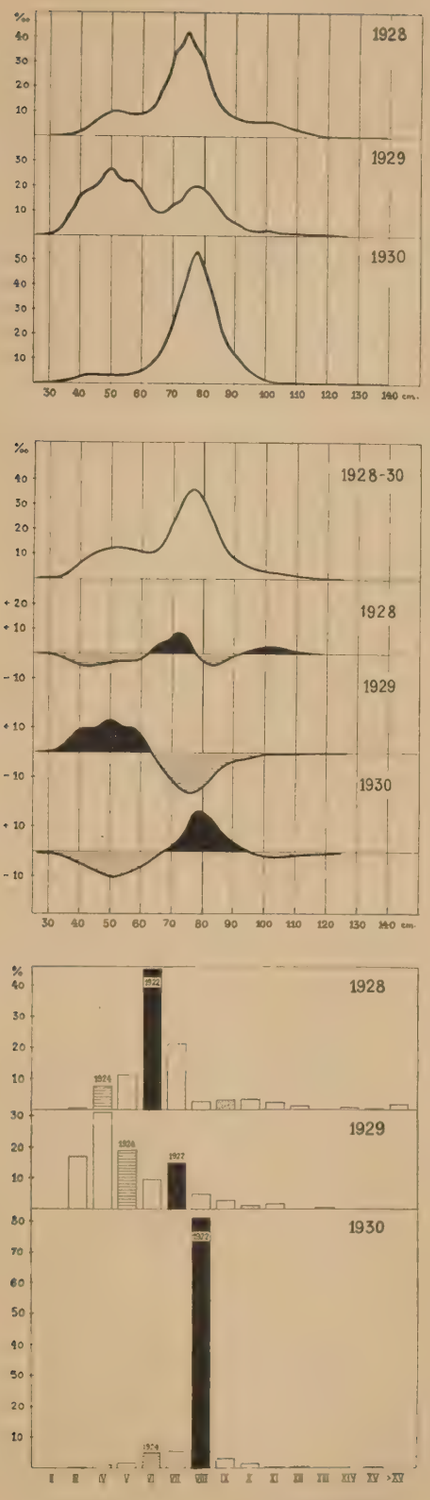

Fig. 6. North Iceland (Siglufjord).

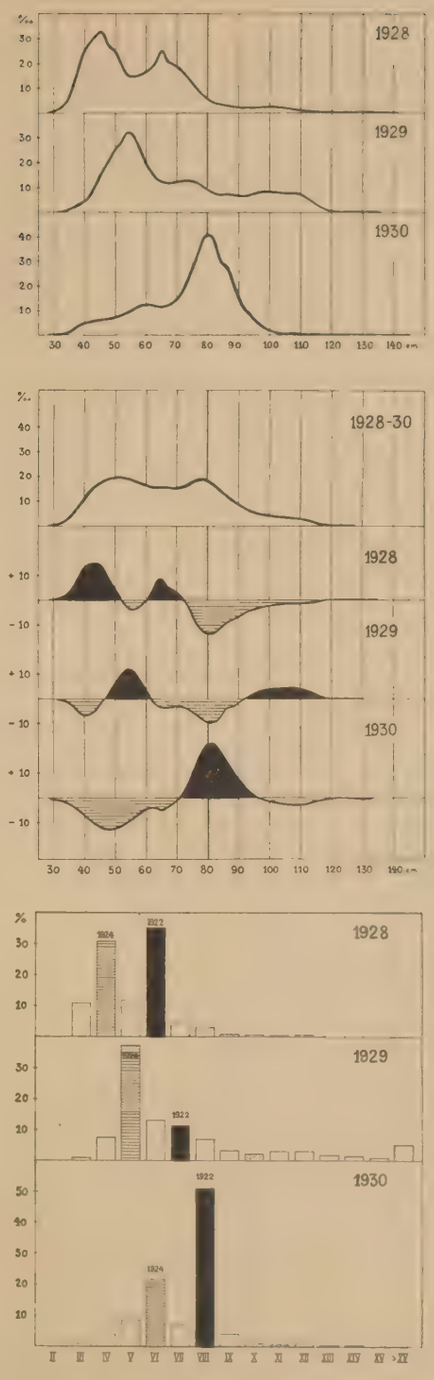

Fig. 7. East Iceland (Nordfjord).

this is the average curve for the three years along with the deviations for each year (1928—30) of the length frequencies from the average of the three years for spawning cod; the lowermost curves give the results of the age analyses, each separate age-group being represented as a column which indicates the procentual strength of the age-group in the whole material analysed.

The measurement curves indicate the sizes of the landed part of the spawning cod stock at South Iceland; as the material is composed almost exclusively of net-caught cod, and thus is a selection of the cod actually on the bank, it can only be considered as a one-sided picture of the cod in the sea. Measurements in 1930 of about 1300 cod taken on long lines (see Fig. 3, p. 11) show a fairly large difference from the cod taken by nets, a difference, however, that is considerably less than what one finds on the feeding grounds of the cod. The long-line material comes in part from almost the same places as the net-caught cod; the last were taken in depths of 90—120 metres, the long-line cod in depths of 70—100 metres. This explains to some extent why the long-line material contains somewhat more smaller cod, but the principal difference is naturally due to the selection by the nets of the larger cod.

The exclusion from the 1930 curve of the line-caught cod (ca. one-third of the material) does not alter in the main the course of the curve, moving it but a little to the right; and the material from the long-line catches can in no way explain the shifting of the curve for 1930 to the left, which is the most obvious difference between the curves of the three years. The shifting of the 1929 curve towards the greater sizes (to the right) and of the 1930 curve towards the smaller lengths (to the left) receive a full explanation from the age compositions in these years.

The curves of the deviations from the average for the three years show clearly that the years 1928 and 1929 were remarkable for a surplus of large and a deficit of small cod, whilst 1930 shows the opposite condition: large excess of small fish and large deficiency of large fish.

The age analyses (lowermost figure) at once give the explanation of the above-mentioned shifting of the measurement curves. We may briefly summarize the results of the age analyses in the following manner:

1928: The year-class 1919 dominates over all the others and amounts to about 30 % of the whole; the 1917, 1918 and 1920 year-classes together represent about 42 % of the catch; the remainder 23 % belongs to different year-classes.

1929: The year-class 1919 is still dominant (ca. 18 %, probably in reality more, see Fig. 1), but the 5 older year-classes are present each with about 10—15 %; only about 10 % of all the fish this year are cod less than 10 years old, whilst of the remainder over 70 % are more than 10 years old fish; this can be clearly seen naturally from the position of the measurement curve.

1930: The year-class 1922 is greatly predominant, making up no less than about 60 % of the total catch[1], though it is only 8 years old. The measurement curve by itself indicates clearly this enormous invasion of the spawning grounds by small fish which are spawning for the first time. In 1930 the 1922 year-class has appeared for the first time on the spawning grounds in any quantity, and this indicates that the age at first-maturity — for this year, at any rate — is 8 years. We see also, that the year-class 1919 is still outstanding amongst the others, but it is completely overshadowed by the abundant 1922 class, although certainly, since the cod are still only 11 years old, it would in normal years have been of no inconsiderable importance.

Thus, whilst we had here on the spawning grounds (cf. Fig. 4 and Tables 7—9) in 1928 about 50 % of cod younger than the X-group, and about 50 % of that group or older, in the two following years we have such a remarkable change in the composition of the stock that in 1929 only 9.4 % of the cod are younger than the X-group, whereas 1930 has no less than 76.9 % younger than the X-class, about 60 % belonging solely to the VIII-group. We imagine that a greater fluctuation from one year to another could hardly occur again

[1] It is possible that this one year-class has contributed over 150,000 tons to the spring fishery of 1930 at South Iceland.

on this the most important spawning ground for cod in the North Atlantic. It may be remarked here, that the spring fishery at the Westmanna Islands in 1930 was greater than in any previous year.

The year-class 1922 has also been very prominent in the case of other species at this part of the Icelandic coasts; for example, I have shown that this applies to the plaice (1929, pp. 37 f., Fig. 9).

It has already been mentioned (p. 11), that a difference could be noted in the respective measurement curves of the cod taken by nets and lines in 1930. Table 6 gives the results of an analysis by age of a nets sample and a line sample. As will be seen, there is no essential difference between the two; the long line catches show a little more of the small fish of the VIII-group and a little less of the large fish of the XI-group, but otherwise there is little difference. As the nets catch only shows 53.5 % of the 1922 year-class where the line catch shows 66.4 %, this would indicate, since the line catches may be taken to give the more correct picture of the relative frequencies in the sea, that the year-class 1922 has been even more strongly represented than is shown in the Fig. 4, p. 12, which gives the whole material combined.

Table 6. Westmanna Isls. April 1930. Frequencies of year-classes in cod from long-lines and nets.

Age-group	Year-class	Long-line, April 2nd-10th		Net, April 11th-19th		Total	
		Number	%	Number	%	Number	%
VI	1924	1	0.4	1	0.5	2	0.4
VII	1923	22	8.8	13	6.5	35	7.8
VIII	1922	166	66.4	107	53.5	273	60.7
IX	1921	23	9.2	13	6.5	36	8.0
X	1920	11	4.4	16	8.0	27	6.0
XI	1919	16	6.4	31	15.5	47	10.4
XII	1918	4	1.6	5	2.5	9	2.0
XIII	1917	3	1.2	5	2.5	8	1.8
XIV	1916	1	0.4	3	1.5	4	0.9
XV	1915	3	1.2	2	1.0	5	1.1
XVI +	1915 ÷	..	..	4	2.0	4	0.9
Total...	..	250	100	200	100	450	100

b. Size and Age.

To understand the differences in the measurement curves from year to year we must undertake a detailled study of the material analysed according to ages. Bjarni Sæmundsson (1923) has already given a valuable account of the cod's growth on the different coasts of Iceland; the locality discussed here is dealt with by Sæmundsson on pp. 7—11. He has studied mainly the first 8 age-groups and only material from the height of summer (July—August). It would be advisable therefore gradually to obtain further information regarding the age and sizes in this important locality, where the spawning cod collect from all parts of the island and where we may expect to find an extremely wide range of variation in the sizes of cod of the same year-class.

Material like the present derived from commercial catches is not ideal for the determination of the size and age conditions, more especially when the fish have been caught in nets, as is the case here for part of the material. In the accompanying tables, however, we give a summary of the data obtained and may remark here that the 1928 material is exclusively of net-caught fish, whilst the 1929 and 1930 data contain about half and half, net-caught and line-caught cod. As already noted previously, the certainty in the determinations of the correct age decreases after the VIII—X-groups, which should be remembered in using the numbers given.

Table 7. Frequency and size at each age. Westmanna Isls. 21.—26. April 1928.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
VI	1922	7	2.3	83.1	79— 88
VII	1921	14	4.6	92.5	88— 99
VIII	1920	41	13.4	92.8	87—100
IX	1919	90	29.4	95.5	83—106
X	1918	45	14.7	96.4	87—117
XI	1917	43	14.1	100.5	93—113
XII	1916	24	7.8	99.9	94—109
XIII	1915	12	3.9	104.6	97—112
XIV	1914	11	3.6	103.8	96—114
XV	1913	8	2.6	102.4	95—107
XVI +	1912÷	11	3.6	(109.8)	(95—146)
Total...	..	306	99.9	..	..

Table 8. Frequency and size at each age. Westmanna Isls. 19. April—9. May 1929.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
VI	1923	3	0.7	72.0	66— 77
VII	1922	8	2.0	85.0	73— 95
VIII	1921	8	2.0	92.9	82—111
IX	1920	19	4.7	95.1	83—106
X	1919	73	18.1	99.3	88—112
XI	1918	63	15.6	102.3	91—112
XII	1917	55	13.7	103.5	95—118
XIII	1916	50	12.4	105.3	87—117
XIV	1915	41	10.2	107.8	97—127
XV	1914	39	9.7	106.4	94—116
XVI +	1913÷	44	10.9	(110.6)	(96—125)
Total...	..	403	100.2	..	..

Table 9. Frequency and size at each age. Westmanna Isls. 2.—19. April 1930.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
VI	1924	2	0.4	79.5	73— 86
VII	1923	35	7.8	82.3	72— 99
VIII	1922	273	60.7	85.1	68—101
IX	1921	36	8.0	92.1	80—111
X	1920	27	6.0	95.1	80—108
XI	1919	47	10.4	98.6	88—110
XII	1918	9	2.0	99.6	94—105
XIII	1917	8	1.8	100.6	95—108
XIV	1916	4	0.9	107.8	101—114
XV	1915	5	1.1	106.2	94—123
XVI +	1914÷	4	0.9	(101.5)	(98—105)
Total...	—	450	100	..	..

One may note that in 1930 not only the VIII-group (1922 year-class) consisted of smaller fish, the IX—XIII-groups were also in that year obviously represented by lower sizes, which can scarcely be explained in any other way than that in 1930 there has been an immigration of all these groups from the east and north coasts, where the growth is known to be slow. This question is of no little interest, since apparently some common factor has been at work, to give rise to the enormous immigration of cod on to the spawning banks at the Westmanna Islands in that year (1930). Observations on the north and east coasts of Iceland have shown, that cod of a great age and as long as 1 metre may be still immature there; this may possibly explain the phenomenon referred to (that low sizes of the older year-groups appeared to be numerous on the spawning banks in 1930, more so than in the previous years); some special or perhaps a specially strong influence has, I suppose, stimulated the dormant migrating (spawning) instinct of these individuals.

Sæmundsson (1923, p. 30) gives for the Icelandic cod the following ages of earliest maturity:

Males: S. and S.W. Iceland: 4—5 years (rarely 3 years).
N. and E. Iceland: 5—6 years "sometimes more".
Females: S. and S.W. Iceland: 5—6 years (rarely 4 years).
N. and N.E. Iceland: 6—8 years (exceptionally 5 or 9).

Our knowledge with regard to this has been extended somewhat by observations in 1930, both males and females of 8 years old occurring in very large numbers as spawning fish on the south coast, though in the previous years there had been nothing remarkable in the occurrence of this group. On the growth grounds round the cold coasts of Iceland, however, large numbers of these 8 year old fish occurred throughout the summer and these were still immature, so that they would enter the ranks of the spawners for the first time as 9 years old (or older). Compared with southern waters (Baltic, for example[1]), where sexual maturity may occur already in the second year, the conditions at Iceland are of the greatest interest.

3. Supplementary samples from the south coast.

To elucidate further the age composition of the cod stock on the western part of the Icelandic south coast we are so fortunate as to possess a small additional material from this region. It has been collected by Dr. Bjarni Sæmundsson in 1930 and he has most kindly placed it at our disposal. The collection was made in March at Grindavík[2] and consists of otoliths taken from a chance portion of cod heads (209 specimens). Measurements of the heads were taken and these show, converted to the total length of the whole cod, similar length frequencies for the fish as at the Westmanna Islands.

The length frequencies arranged in 10 cm. groups work out as follows:

Table 10. Length of Cod. Grindavík, March 1930.

cm	50—59	60—69	70—79	80—89	90—99	100—109	110—119	120—129
Nos.	8	25	70	52	48	3	1	2

The analysis by age yielded the following picture:

Table 11. Age analysis of Cod. Grindavík, March 1930.

Age-group	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI+
Year-class	1924	1923	1922	1921	1920	1919	1918	1917	1916	1915	1915÷
Number	2	23	93	10	9	20	6	13	8	6	18
%	1.0	11.1	44.7	4.8	4.3	9.6	2.9	6.3	3.8	2.9	8.7

[1] cf. E. M. Poulsen, 1931, pp. 63—66. [2] See Fig. 2, a.

As will be seen, the year-class 1922 is easily dominant, and of the earlier years 1929 and 1917 were better than the neighbouring years. The sample was thus in agreement with the material from the Westmanna Islands.

Of interest in this connection is likewise a similar material (but without measurements) also collected by Dr. BJARNI SÆMUNDSSON at Grindavík in 1925. The collection were made in the months of January, February, March and April. From this material we obtain a very good picture of the age composition at a period when no young year-class was specially dominant, but where the catches were composed of a whole series of older classes. Owing to this fact about 13 % of the samples had to be excluded as indeterminable, and the determinations from the otoliths of cod over 9—10 years old are by no means so certain as those obtained from the otoliths of younger fish. January—March specimens are taken as in the foregoing to belong to the year-class which in reality should not begin until the following April.

Table 12. Age analysis of 1925 Grindavík material.

Age-group		V÷	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII÷	Total determined
Year-class		1919+	1919	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908	1908÷	
January	Number	..	7	12	20	20	27	36	45	25	25	11	6	7	9	250
	%	..	2.8	4.8	8.0	8.0	**10.8**	**14.4**	**18.0**	**10.0**	**10.0**	4.4	2.4	2.8	3.6	
February	Number	4	6	12	24	31	51	39	50	25	18	16	13	6	5	300
	%	1.3	2.0	4.0	8.0	**10.3**	**17.0**	**13.0**	**16.7**	8.3	6.0	5.3	4.3	2.0	1.7	
March	Number	5	6	14	24	21	29	40	56	41	22	17	8	8	9	300
	%	1.8	2.0	4.7	8.0	7.0	9.7	**13.3**	**18.7**	**13.7**	7.3	5.7	2.7	2.7	3.0	
April	Number	25	21	31	36	38	31	26	43	21	7	9	4	2	6	300
	%	8.3	7.0	**10.3**	**12.0**	**12.7**	**10.3**	8.7	**14.3**	7.0	2.3	3.0	1.3	0.7	2.0	

Year-classes with over 10 % are emphasized. It will be seen that the groups VII—XIV contribute mostly to the catches, as also that the younger groups are more in evidence late in the season, a well-known phenomenon in the coast fishery. The principal year-classes seem to be 1913 and then 1915, but several of the neighbouring classes from 1911 to 1918 do not seem far behind those mentioned.

A comparison with the March 1930 sample clearly shows the extraordinary difference there may be in the age composition of the stock fished. Whilst the year-classes younger than IX were only represented in 1925 by amounts of less than 12 %, one year-class in 1930 shows no less than about 45 % in this part of the stock.

B. North-West Iceland. Isafjord.

1. Material and remarks on the material.

The size of the material from this area will be seen from the table on p. 9; about 13,000 measurements and 1300 age determinations were made.

Proportion of the sexes. The Table 33, p. 38 shows that the percentage of females lies between 42 and 49, somewhat lower than at North and East Iceland, where the percentage of females almost always exceeded 50 by a little. On the other hand, the percentage of females in the north-west is usually considerably above that found on the well-known spawning grounds farther south. The cause of this intermediate position in the north-west, with regard to the proportion of males and females, may be supposed to lie in the condition, that a small part of the cod in the north-west may be spawning cod, and the quantitative proportions of males and females on the spawning grounds at Iceland seem always to be against the females.

The fishery on the north-west coast may be carried on practically the whole year through, but

the principal season is restricted to the months of March-June; the period for the best fishery may vary from year to year. In the years 1929—30 the fishery was somewhat earlier than in the preceding years; generally it begins with March (see fig. 11, p. 39). The fishing is carried on along the edge of the Isafjord Deep, especially on the south side of the fjord and at the mouth, but the boats often go out many miles (14—18 miles or more). Fish are also landed in the Isafjord district both from north and south of the fjord and some of the larger boats (about 7 of 30 tons) go northwards to fish north-east and south-east of Cape North (Horn) and south as far as Snæfellsnes. Such voyages last about 7—10 days, but material from these boats could not be included in this work as the fish are salted on board. The present material was obtained partly from boats landing their fish in Isafjord town itself, partly in Hnifsdal and Bolungarvík. The boats from these places fish, however, at the same spots for a great part (some 40 motor boats of 4—20 tons and about 40 rowing boats, some with auxiliary motor). Only long-lines were being used in the fishery when the collections were made (bait: herring and Cyprina islandica; the former especially in the fishing for the large cod out in the Deep, the latter in the fishery at the mouth of the fjord and somewhat farther out). Hand lines have also been used, though to a small extent, from some of the other north-west fjords in these years. Sometimes the fishery takes place quite close to the land (e. g. in the spring of 1929); the depth at the fishing places varies from 60—180 metres, mostly 100—160 metres.

The fish landed consist for the most part of immature cod; few cod over 85 cm. are present and they are mainly spent or immature cod, yet as mentioned some spawning may occur on the northern part of the west coast. At no other parts of Iceland have I met with such small spawning cod as in the mouth of the Isafjord; presumably we have here a local stock of fjord cod. Schmidt (1904, p. 58) has mentioned this late spawning in north-west Iceland (May—June) partly on the basis of Bjarni Sæmundsson's observations.

1928: some mature cod were taken in May; the smallest almost fully ripe female of 46 cm. (V-group) was caught on May 15th off Hnifsdal-Bolungarvík.

1929: the fishing is said to have been at its best in the months of February—March and the number of spawning cod to have been larger than usual; even in May some spawning fish were met with (on May 21st in about 500 cod examined at Hnifsdal 4—5 had large roes, two with running eggs).

1930: In this year also there is said to have been more spawning cod than usual. As late as May 30th spawning fish were taken off Hnifsdal-Bolungarvík (60 fathoms); the two smallest females with running spawn were 53 and 54 cm. long. On June 3rd there were still some spawning fish in the catches (smallest female with running spawn 56 cm.). As usual more ripe males than females were in the catches.

2. Measurements and age composition.

a. Fluctations.

Fig. 5 indicates the composition of the cod stock in this region in the years 1928—30. The measurements are given in the Tables p. 42, the age analyses in Tables 15—18, p. 22—23. As before the measurement curve is given uppermost in Fig. 5, then the deviations from year to year and lowermost the results of the age analysis.

The measurements from this area show first and foremost, that the stock of cod fished consists of young fish, just as in the main on the north and east coasts. Further, they show — as can also be seen from the curves for the deviations from the average — that the differences between the three years are not nearly so great as on the north and east coasts. This greater uniformity in the catches from the three years for this area, in contrast to the others, cannot be explained with any certainty. It is conceivable that the large Isafjord area possesses a quite local and stationary stock of cod, which affects the picture obtained from the passing, migratory stock of cod to such an extent that the area is not suited to display changes in the stock of bank cod round the whole island; it is also conceivable, however, that the meaning of the curves will

be more easily interpreted after collections have been made over a longer series of years, to eliminate chance fluctuations.

The 1928 and 1930 curves have the maximum almost at the same place, though as shown by the age analysis this comes mainly from the presence of the same year-class (1922), which was only 6 years old in 1928, but 8 years old in 1930. Owing to growth one would *a priori* expect a considerable shifting of the maximum to the right in 1930 by comparison with 1928, but this is by no means the case. Without venturing upon explanations, which in any case could only be suppositions, I may point out that in all probability the Isafjord fish taken in 1930 came from quite a different part of the year-class 1922 than the 1928 lot; the immigrants in 1930 namely may have come from North and East Iceland or from Greenland[1] or from both, and thus, owing to a slower growth where they came from, consisted of considerably smaller cod than the part of the 1922 class which grew up on the spot (N.W. Iceland) and in 1930 had migrated to the spawning places on the southern banks.

The age analyses gave the following results for the 3 years:

1928: the year-class 1922 is very dominant and amounts to about 37 % of the whole catch.

1929: the year-class 1922 retreats in favour of a number of younger classes (1923, 1924, 1925) but no year-class is specially prominent.

1930: the year-class 1922 is again very dominant, amounting to about 39 % of the whole catch. The younger classes — 1923, 1924, 1925, 1926, 1927 — are also present in quite small proportions with about the same amounts.

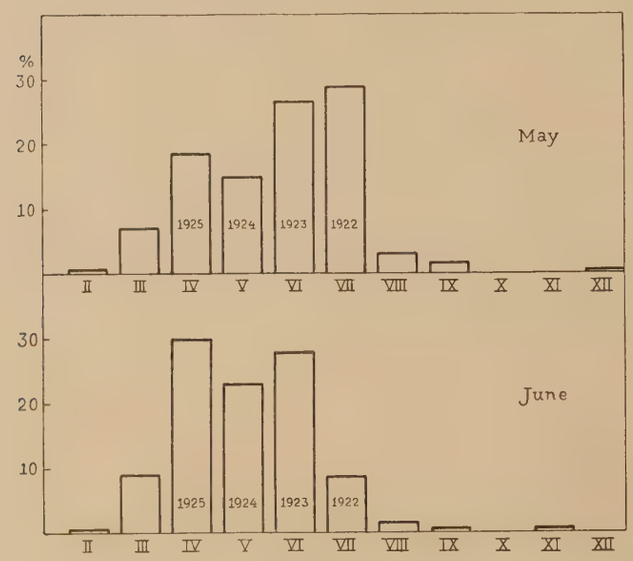

Fig. 8. Percentage of age-groups. Isafjord May and June 1929.

Taken on the whole there is no doubt, that the year-class 1922 here as elsewhere round Iceland is strongly represented, but its relative disappearance in 1929 is extremely interesting and characteristic, all the more as we find the same or a similar phenomenon in 1929 at the other parts of Iceland where the group has grown up.

From the Isafjord area we are so fortunate as to possess age samples taken 1929 with about a month's interval between; one sample from 12.—27. May, the other from 22.—27. June. The age analyses of these two samples appear in Fig. 8, and one may notice in the lowermost graph that the greatest shifting during the course of the month has taken place in the 1922 group, i. e. the largest fish have in great part emigrated. Taking the three groups III, IV and V separately and taking the sum of the age-determined individuals of these three groups as 100 %, we have the following procentual frequencies in the two months.

Table 13. Procentual frequencies of groups III, IV & V. Isafjord 1929.

	III	IV	V	
May	17	46	37 %	(113 spec.)
June	14	49	37 %	(162 spec.)

Comparatively little change has thus taken place in the relations of these three groups and the addition of the VI-group makes no great change in the picture. The groups of small cod have thus remained stationary

[1] cf. Johs. Schmidt, 1930 and 1931.

in their relative proportions, whereas the larger cod — especially of the VII-group (1922 class) — have migrated away. It is also a well-known phenomenon, that towards the end of the fishing season the small fish increase in numbers on the fishing banks, the explanation being assuredly that the departure of the larger fish has given the smaller a better chance in regard to food and additions of small cod have come from the bays and fjords. It may be noted that half of the May sample, taken 12.—15. May, contains about 50 % of the year-class 1922, whilst the other half, taken 24.—27. May, only contains about 20 % of the 1922 class; the emigration thus seems to have taken place just after the middle of May.

In certain years or at places where such an emigration is very marked, the collection of material over a brief interval of time will obviously give a very misleading picture of the stock in the sea throughout the whole season. To counteract this we require an extension of the number of samples for age determination, as these will clearly show the changes occurring where the growth conditions on the different coasts are so extremely variable and where additions from one coast to another cannot always be detected in the measurement curves.

The whole of the age-analysed material for 1929 has been brought together in the graph Fig. 5, a separation of the more or less correct being hardly possible.

The frequencies work out as follows:

Table 14. Isafjord; May—June 1929.

Age-group.....	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Year-class.....	1927	1926	1925	1924	1923	1922	1921	1920	1919	1918	1917	
Number	2	42	131	102	149	103	12	5	..	1	1	548
%.....	0.4	7.7	23.9	18.6	27.2	18.8	2.2	0.9	..	0.2	0.2	100.1

b. Size and age.

Bjarni Sæmundsson (1923, pp. 16—22) has discussed the age and growth of the cod at North-West Iceland. His material consisted of July—August samples in part from Patreksfjord, from Isafjord Deep and in part from the banks off the north-west fjords. As in the present material, only the age-groups younger than 9 years are represented, practically speaking, indicating that the majority migrate at the age of 7—9 years and that the older cod occurring on this part of the coast are to be found farther out towards deeper water (a sample of cod taken by the "Dana" in 1927 (9—10/VIII) out at Hali (Djupálsrif: 66°53′ N., 24°42′ W.; 190 metres) contained about 32 % of the year-classes older than the VIII-group). The larger specimens of the different age-groups can be seen from Sæmundsson's tables (p. 17—18) to have come from the banks. The cod from the Isafjord Deep (l. c. Table 3, p. 18) were taken for the most part in shallow water and cannot be compared therefore with the present material.

Without going into a too detailled account of the material shown in the Tables 15—18, I may note that the Tables 16 and 17 for 1929 give some idea of the growth in the course of about a month which lies between the two samples (May—June). The growth is about 2 cm. (the VII year-group shows somewhat more, 6 cm.). A comparison of the 1930 Table (18, p. 23) with the corresponding ones for 1928 and 1929 shows that of the year-groups getting ready to spawn, or which possibly have spawned that same year, it has been the smaller sizes which were met with in Isafjord, the 1930 average for these year-groups being lower than the average for the other years. This may have come partly from an extensive emigration of the larger fish to the spawning places farther south, partly from a greater than normal addition of small fish from the north coast; only extensive marking experiments can determine this with certainty.

Even if but little of the IX and later groups is present, one may note that there is a sudden rise of the

Table 15. Frequency and size at each age. North-west Iceland. Isafjord. 8.—19. May 1928.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
II	1926	2	0.6	31.0	29—33
III	1925	19	5.9	40.4	35—47
IV	1924	24	7.5	51.3	37—59
V	1923	55	17.1	61.8	47—70
VI	1922	118	36.8	70.8	57—87
VII	1921	58	18.1	76.9	65—92
VIII	1920	20	6.2	79.3	67—91
IX	1919	9	2.8	96.0	73—105
X	1918	7	2.2	98.4	89—107
XI	1917	4	1.3	104.3	101—112
XII	1916	2	0.6	102.0	93—111
XIII	1915	..	..	..	..
XIV	1914	..	..	..	..
XV	1913	2	0.6	113.0	109—117
XVI +	1912÷	1	0.3	117.0	117
Total...	..	321	99.9	..	..

Table 16. Frequency and size at each age. North-west Iceland. Isafjord. 12.—27. May 1929.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
II	1927	1	0.4	32.0	32
III	1926	19	6.7	40.2	33—51
IV	1925	52	18.4	50.3	39—61
V	1924	42	14.9	57.6	49—69
VI	1923	75	26.5	65.9	51—79
VII	1922	81	28.6	71.3	58—92
VIII	1921	8	2.8	78.3	67—88
IX	1920	2	0.7	88.5	85—92
X	1919	..	..	..	..
XI	1918	2	0.7	95.5	92—99
XII	1917	1	0.4	125.0	125
Total...	..	283	100.1	..	..

Table 17. Frequency and size at each age. North-west Iceland. Isafjord. 22.—27. June 1929.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
II	1927	1	0.4	30.0	30
III	1926	23	8.7	43.4	39—52
IV	1925	79	29.8	52.7	40—60
V	1924	60	22.6	59.6	53—70
VI	1923	74	27.9	67.5	56—82
VII	1922	22	8.3	77.1	62—93
VIII	1921	4	1.5	80.3	70—87
IX	1920	1	0.4	100.0	100
X	1919	..	..	..	..
XI	1918	1	0.4	116.0	116
Total...	..	265	100	..	..

Table 18. Frequency and size at each age. North-west Iceland. Isafjord. 30. May—6. June 1930.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
II	1928	1	0.2	37.0	37
III	1927	53	12.5	43.2	35— 50
IV	1926	49	11.5	51.5	43— 61
V	1925	47	11.1	59.0	45— 69
VI	1924	53	12.5	63.8	50— 85
VII	1923	46	10.8	68.8	56— 85
VIII	1922	165	38.8	75.9	57—103
IX	1921	2	0.5	93.0	89— 97
X	1920	2	0.5	89.0	70—108
XI	1919	1	0.2	89.0	89
XII	1918	1	0.2	95.0	95
XIII	1917	..	..	..	..
XIV	1916	1	0.2	107.0	107
XV	1915	1	0.2	121.0	121
XVI +	1914÷	3	0.7	112.7	103—131
Total...	..	425	99.9	..	..

average length from the VIII-group (with a length of 75—80 cm.) to the IX and still older groups, with an average about 90 cm. and higher. The reason for this partly and chiefly is, that the large specimens of the VIII-group, owing to the change over to the mature condition, have emigrated from the district[1], thus lowering somewhat the average size of the VIII-group, partly also in the possibility, that the IX and following groups belong to the stock of bottom cod which, after spawning once or several times, have withdrawn from the shoals of wandering cod and thereafter make up the stock of older cod which lead a more or less stationary life.

C. North Iceland. Siglufjord.

1. Material and remarks on the material.

The extent of the material will appear from Table 2, p. 9; about 18,600 measurements and about 1200 age determinations were made. In 1928 and 1930 the measurements date from the beginning or middle of June; in 1929 from late in May and also from July.

Proportion of sexes. From the Table 33, p. 38 it will be seen, that the proportion of the two sexes at this place, where the stock consists of growing cod with but little mixture of immigrant older fish, is almost the same, the females preponderating slightly (50.1—52.2 % females).

The fishery at North Iceland, which is mainly a fishery of immature cod but also of immigrating spent cod, takes place on this part of the Icelandic coasts chiefly in June—August. At the place where the material comes from, Siglufjord, it was considered formerly that the fishery began on June 6th; in later years, however, the fishery has been good throughout the whole month of May (see Fig. 11), some even in April, though not of great extent, and a little earlier, whilst at the other end it may last to the end of the year. The main season, however, is in summer, especially June, the stormy weather of the other seasons being probably the cause of this. The Siglufjord fishery has greatly increased within recent years, from about 15,000

[1] A comparison of the sizes of the 1922 year-class from North-West Iceland and from South Iceland in 1930 seems to support this view. The age-determined, long-line cod from the Westmanna Isls. show an average length of 83.5 cm. for the VIII-group in 1930, that is 7.6 cm. greater than the average of the long-line cod of this group taken in the same year in the Isafjord area (75.9 cm.); apparently, part of the north-west stock has migrated to the spawning places at the Westmanna Islands in that year. Any mixing with the more southerly and more rapidly growing cod however cannot be determined.

Skippund (à 160 kg.) in 1926 up to three times that amount in 1929 and 1930. Boats from many places collect here during the fishery, from Akureyri, Westmanna Isls. etc. During the main season the fishery is carried on especially within an area of about 15 miles in a semicircle with Siglufjord as centre; later the boats spread out more, to the east side of Eyjafjord Deep, Skagagrunn, Skagefjord and out to Grimsey. In the middle of June 1928 the boats (chiefly motor boats) numbered 60—70, fishing from Siglufjord. The place is specially well suited to the collection of a representative material of the north coast fisheries. We may believe that the material is rather representative of the stock on the banks, the fishing being carried on exclusively by long lines (for this reason and because the fishery takes place largely in deeper water, the smallest cod are not so well represented, yet small cod may be taken in quantities right out to 165—240 metres). Fishing is most often carried on at great depths, about 125—250 metres, but good fish may at times be caught in less depths down to 40 meters. The fish of 85—90 cm. and over are practically all spent fish, and it is rare to find a single specimen in which the development of testis or ovary might indicate, that it would spawn in the course of June—July or, from the presence of reddened testis or residual eggs, that it had spawned recently and thus not very far away (on the north-west coast?). Immature specimens of considerable length may occur, for example a female of 94 cm. on 5/VI, 1928. The bait used is always, or almost always, fresh or frozen herring, but also at times the capelin (Mallotus) when herring are not to be had.

1928: There was a little fishing in April, but it was still very uncertain throughout May until about the 27th, when the catches increased.

1929: Owing to favourable weather conditions, the fjord not being filled with ice, fishing could be carried on even during the winter of 1928—29, though on a small scale. At the end of March and beginning of April, a number of large cod had developed roes; this class of fish disappeared in April, which the fishermen ascribed to a great storm, but the fish may have migrated at this time to the north-west to spawn. As late as 31/V some of the samples might contain 5 % of fish with large roes or milt (> 80 cm.). The high temperatures in the water along the western part of the north coast this spring have possibly led to a number of cod spawning there[1]. The liver production was small this year as at other places round Iceland (there is said only about 1 barrel against 4 for the same amount of cod).

1930: As in 1929 the fishery might have begun much earlier than usual, and might possibly have been carried on throughout the winter, had the weather not been unfavourable; during most of the winter the fish were obviously present on the banks. The fishery was better than in any previous year. As in 1929 some few cod were taken with well-developed sexual organs; one ovary of a large cod on 16/VI had a number of clear eggs scattered about in the ovary; the fish was thus approaching maturity.

In earlier years the cod fishery has for the most part ended when the herring fishery began in July; in recent years, however, a cod fishery has been developing independently of the herring fishery, being continued even in the busy herring season (July—September). As everywhere at Iceland the bait question is of decisive importance, and the fishery is still far too up dependent on chance in this way; late in June 1930 — in the best period — the fishery was quite held up owing to the lack of bait; neither fresh, frozen nor salted herring could be got; there is apparently a need for better organisation here (fresh herring at times may reach the formidable price of 75 Kroner icel. per Td.).

[1] Schmidt (1909) has shown that practically the whole of the cod's spawning takes place to the south and west of Iceland, but notes (p. 21, footnote) that quite small quantities of eggs and fry may occur on the north and east coasts (cf. also Tables, l. c. p. 217); this spawning on the cold coasts is hardly of any importance relative to the size of the stock. During the cruise of the "Dana" round Iceland in 1924 from 2.—9. June I succeeded in hatching out some gadoid eggs (taken in a silk net of 1 m.) and found that a small number belonged to *Gadus callarias* both on the east and north coasts.

2. Measurements and age-composition.

a. Fluctations.

Fig. 6, p. 13 gives a review of the composition of the cod stock on this part of the coast in the years 1928—30. The measurements are given in the Tables p. 42, the results of the age-analyses in Tables 19—21. As in the previous graphs the measurement curve is uppermost in Fig. 6, then the deviations from the average of the three years and lowermost the results of the age-analyses.

The measurement curves from this area, as for the previous and later areas, show that the catch consists mainly of immature fish mixed with a number of older cod which arrive here on their food wanderings after spawning on the warmer coasts. Whilst the curves are extremely alike in 1928 and 1930, this is not the case for the 1929 curve. As can be seen from the curve of the deviations from the average, the 1929 curve shows a large excess of small fish and a large deficit of larger fish. The reason for this lies partly in the fact that the great mass of the measurement material comes from a period when the small fish were specially dominant in the catches. We may emphasize this, as it shows clearly that to obtain a representative picture

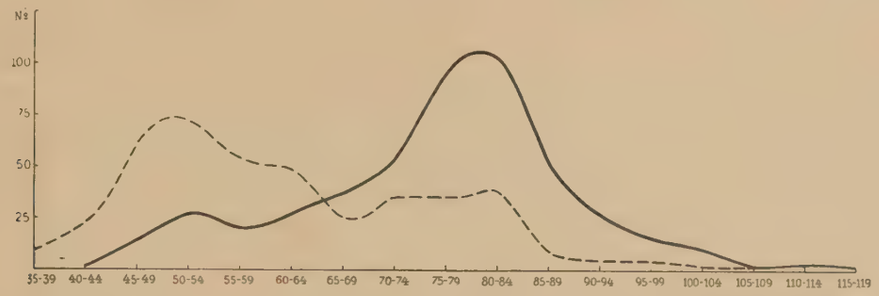

Fig. 9. The length frequency distributions of cod, Siglufjord, North Iceland 1929. Long lines. ——— 31. May 1929: 490 specimens. ——— 16. July 1929: 432 specimens. Length in 5 cm. groups.

of the part of the stock, which is being fished, one should collect the material throughout the whole season and not be content with material from a shorter period with little prospect of an accurate result. The 1929 material was collected late in May and in July; Fig. 9 gives an impression of the difference in the fish taken about June 1st from the fish caught in the middle of July (the two samples are almost of the same size). It is seen clearly that abt. June 1st fish of the sizes which represent the VII-group (year-class 1922) were very numerous, whereas in July the earlier age-groups III—V were dominant. In dealing with the Isafjord material we have already been obliged to note, that great changes in the stock of cod took place in the course of 1929; the same obviously applies to this place in that year.

We can show in another way, that the larger fish were numerous at a certain part of the summer, after which they again gave way to the small fish. In the fisheries statistics of Iceland a distinction is made between large and small cod and the curves fig. 12, p. 39 indicate the conditions in Siglufjord during the whole season (statistics from "Ægir" 1928—30). The curves show the percentage of small fish on the first of each month for the three years 1928—30 and show, that large cod are more numerous in the catches in May 1929, decreasing gradually in June—July relative to the small cod. The 1929 material of measurements and age-analyses bears the mark of this distinctly and we can therefore say, that the 1929 age samples for the month of July contain too few of the year-class 1922 to be representative of the real strength of that class at the principal part of the fishing season (May—June).

The 1928 and 1930 measurement curves are very similar and the maximum point has but little changed in the course of the two years, though it is the same year-class which is dominant in both years. This is undoubtedly due to the gradual emigration of the individuals of the 1922 year-class as they become sufficiently

large, to be replaced by immigrating smaller fish from the eastern part of the north coast and perhaps also from the east coast.

The age-analyses give the following results for the 3 years:

1928: the year-class 1922 is strongly dominant and amounts to about 45 % of the whole catch.

1929: the year-classes 1924, 1925 and 1926 are more dominant than 1922, but in view of what has been noted above the year-class 1922 would certainly have shown an absolute dominance, if the material had been collected at an earlier period of the fishery.

1930: the year-class 1922 is in great preponderance, amounting to about 80 % of the catch this year.

For North Iceland 1928—30 we have thus the same result as at North-West Iceland; the year-class 1922 is very dominant. Of the other year-classes there is in 1928 and 1929 somewhat of the year-classes 1921, 1924, 1925 and 1926 just as on the north-west coast, whilst of these, as will be seen in the next section, only the year-class 1924 is of importance on the east coast.

b. Size and age.

The size and age of the cod at North Iceland have been discussed by Sæmundsson (1923, pp. 22—25, with the Tables 1—3, pp. 19—23); the material was from the eastern part of the north coast from Eyjafjord eastwards. The size in relation to age agrees very well in the two materials, Sæmundsson's and the present. This applies especially to the 1929 material which like Sæmundsson's was collected in the month of July. As one might expect, the average size of the youngest age-groups (III—V) is less in Sæmundsson's material than in ours, as he had a considerable number of these small cod from inside the fjords.

It will be noted, that just as at Isafjord the specimens of the year-classes getting ready to spawn are throughout smaller in 1930 than in the previous years; presumably this is to be explained as before by immigration and emigration. In that year, however, the emigration from North Iceland has evidently not been quite so great as from North-West Iceland; nor was this to be expected, as the north-

Table 19. Frequency and size at each age. North Iceland. Siglufjord. 6.—11. June 1928.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
III	1925	1	0.3	46.0	46
IV	1924	23	7.4	50.6	43— 58
V	1923	34	11.0	65.1	47— 77
VI	1922	140	45.3	73.8	56— 89
VII	1921	65	21.0	80.2	68— 92
VIII	1920	8	2.6	89.6	78—105
IX	1919	9	2.9	93.8	83—100
X	1918	10	3.2	96.1	87—102
XI	1917	7	2.3	108.3	98—128
XII	1916	4	1.3	108.8	96—120
XIII	1915	..	..	..	..
XIV	1914	2	0.7	111.5	110—113
XV	1913	1	0.3	103.0	103
XVI +	1912 ÷	5	1.6	111.2	107—117
Total...	..	309	99.9	..	..

Tabel 20. Frequency and size at each age. North Iceland. Siglufjord. 19.—21. July 1929.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
III	1926	77	16.7	40.7	36— 48
IV	1925	143	31.0	48.2	40— 60
V	1924	85	18.4	57.4	42— 70
VI	1923	43	9.3	67.7	53— 84
VII	1922	69	14.7	79.3	67— 94
VIII	1921	22	4.8	88.9	75—102
IX	1920	12	2.6	96.6	85—114
X	1919	4	0.9	107.0	98—115
XI	1918	7	1.5	108.1	104—116
XII	1917	..	..	..	..
XIII	1916	1	0.2	121.0	121
XIV	1915	..	..	..	..
XV	1914	..	..	..	..
XVI +	1913÷	..	..	..	..
Total...	..	463	100.1	..	..

Table 21. Frequency and size at each age. North Iceland. Siglufjord. 14.—21. June 1930.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
III	1927	1	0.3	41.0	41
IV	1926	4	1.0	49.5	48— 53
V	1925	7	1.7	54.0	44— 60
VI	1924	21	5.2	67.9	53— 78
VII	1923	23	5.7	74.8	67— 89
VIII	1922	329	80.8	79.8	62— 99
IX	1921	13	3.2	86.7	74— 95
X	1920	6	1.5	97.7	86—106
XI	1919	1	0.3	90.0	90
XII	1918	1	0.3	84.0	84
XIII	1917	..	..	..	..
XIV	1916	..	..	..	..
XV	1915	1	0.3	111.0	111
XVI +	1914÷	..	..	..	..
Total...	..	407	100.3	..	..

west cod probably become mature a little earlier than the others. Taking the average size of the cod in the years about first-maturity we have the following results from Isafjord and Siglufjord for 1930:

Table 22. Average size of Cod from Isafjord and Siglufjord 1930.

Age-group	V	VI	VII	VIII	IX	X
Isafjord	59.0	63.8	68.8	75.9	(93.0)	(89.0) cm.
Siglufjord	(54.0)	67.9	74.8	79.8	(86.7)	(97.7) cm.

(Averages from less than 20 specimens in brackets).

These figures clearly indicate that cod of the same age (older than the V-group) are larger in Siglufjord. The Isafjord samples date from May 30th—June 6th, those from the Siglufjord from June 14th—21st; this difference in time, however, cannot explain the whole difference in length. The depth at which the catches

were made possibly helps in the same direction as the difference in time, as the Siglufjord catches were on the whole from slightly greater depths. It may be remarked in the tables on the preceding pages, that the age-groups V and younger are on the whole larger at Isafjord than at Siglufjord (as one might expect from the temperature conditions), whereas the VI—VIII-groups are distinctly smaller at Isafjord than at Siglufjord. The migration of the cod from and to the north coast of Iceland may, I suppose, be taken first and foremost as responsible for these size differences (cf. also p. 19 relating the probability of a special race of fjord-cod in Isafjord).

We should not have discussed these conditions in so much detail, however, if earlier investigations had not given a certain amount of support for the actual existence of this difference in length between medium-sized fish of the same age from North-West and North Iceland, contrary even to what one would expect. Something similar was found in regard to the plaice (TÅNING 1929, p. 80) and only in the slightly older age-groups which for the most part had not yet spawned.

As mentioned, we are disposed to ascribe the phenomenon mainly to migrations, but it is not excluded that the change in the mode of life with the size (food) may result in a greater increase in growth at North Iceland just when the cod become about 5 years old (50—70 cm. long) and can pursue, for example, the capelin and herring with greater expertness. It may be added that SÆMUNDSSON (1923) does not discuss this matter, but his materials were collected from widely separated years and places, which excludes the possibility of investigating the conditions mentioned.

D. East Iceland. Nordfjord.

1. Material and remarks on the material.

The size of the material and the period of collection will be seen from Table 2, p. 9; altogether 16,600 measurements and about 1400 age determinations have been made. In 1928 and 1930 the observations were made in June—July, in 1929 in May.

Proportion of the sexes. From Table 33, p. 38 it will be seen, that the procentual distribution of the sexes shows the females present with 50—55 %; the majority of the cod are immature, but the presence of large spent cod may influence the proportions to some extent.

Whilst the percentage of females at North Iceland did not exceed 52 %, here at East Iceland it was about 55 % in 1930, due to the presence of a considerable number of large spent females over about 85 cm. in length, as the accompanying summary shows.

Table 23. Proportion of the sexes. Nordfjord 1930.

Length	Number of ♀♀	Number of ♂♂	Percentage of ♀♀
> 110 cm.	19	5	79.2
100—109 -	44	14	75.9
90— 99 -	325	124	72.4
85— 89 -	427	254	62.7
> 85 cm.	815	397	67.2
< 85 -	1762	1719	50.6

The fishery, which is mainly based on the immature cod[1], and to a certain extent also on migrating spent cod, is a summer fishery mainly — May to July-August, but may begin already in March and continue to November—December (see Fig. 11, p. 39). At South-East Iceland the trawlers begin fishing on the slopes of the banks out towards deep water in early spring (about April), and even in mid-winter there may be

[1] On the east coast about 2/3rds are small cod (from the Iceland Statistics 1905: 66 % smáfiskur, 34 % þorskur; same year North and West coasts 62 % & 60 %, and South coast 16 % smáfiskur; SÆMUNDSSON 1926, p. 237).

some fishing on the east coast banks, whereas on the north coast east of Hunaflói the fishery is or has been quite inconsiderable in the period from November to April.

The cod fishery of East Iceland has not increased in recent years at the same scale as on the north and north-west coasts (see Table 34, p. 41).

In former years a large number of Faroese fished with open boats from the fjords of the east coast; this fishery has declined rapidly; in Nordfjord (previously one of the most important places for this fishery) there were in 1928 only 4 Faroese boats (with 12 men) fishing against none in 1930.

From Nordfjord fishing is carried on northwards to Hjeradsflói and southwards to Seley; the fish are landed fresh, ungutted, by some of the boats; others which salt onboard have a wider range, northwards for example to Langanes. In the years of investigation about 40 open boats, 12 motor boats under 12 tons and 4 over 12 tons worked from Nordfjord; as also a single large vessel for salting the cod onboard. Most of the boats, however, fished within a range of about 10—13 miles from the mouth of the fjord. The fishery is carried on mainly by means of long lines, though hand lines are used by some of the boats. At the times when the collections were made the fishing was carried on in depths of about 20—220 metres, usually 80—150 metres.

The fish are as mentioned either immature or spent, the latter immigrants probably from the south coast. It is extremely rare to find cod in the stages about the spawning condition; now and then about the endof June or beginning of July I have met with males with running milt (e. g. 1 spec. of 71 cm. on July 1st, 1930); more rarely one meets with a single female with large roes, but none with running roes has been seen by me on this part of the coast[1].

As will be seen from the curves Fig. 11, p. 39 the east coast fishery is more uniformly spread over a longer period than, for example, on the north coast, but the main season is in May—July as mentioned above; no great difference in the time of the chief fishing has been noted in the three years of the collections, but on the whole the maximum of the fishery has been a little earlier than normally. The earlier fish are large, but the percentage of small cod gradually increases as the season progresses; there seems to be a certain and somewhat regular rise and fall in the relations between small and large fish throughout the season (due possibly to their frequenting certain grounds at certain times). The midsummer (July) fish for example are said to be somewhat larger than the fish taken a little earlier, and larger cod are also said to be caught in the autumn. As will be seen from the curves, these statements of the fishermen are confirmed by the statistics. Nordfjord is undoubtedly a good place for the collection of material from this part of Iceland, but the changes mentioned have to be taken into consideration in the continuation of the work. As at other places it is of importance to have measurements taken through the whole season.

The largest cod I have seen on the east coast during these years have been 140—146 cm. long (for example, ♀ of 140 cm. July 8th, 1930, Nordfjord, age-group XVI; 146 cm. ♀ July 10th, 1930, Nordfjord, ca. XVII).

2. Measurements and age-composition.

a. Fluctuations.

Fig. 7, p. 13 summarizes the composition of the cod stock at East Iceland in 1928—30. The measurements are given in the Tables 42, the results of the age analyses in Tables 24—26, p. 30. As in the corresponding graphs for other places the measurement curve is uppermost in Fig. 7, then the deviations from the average for the three years and below the results of the age analyses.

The measurement curves for this area like those for the two preceding show, that the catches are mainly of immature fish, at least numerically, but also contain a number of older fish on their food wanderings after spawning, which probably come exclusively from the south coast.

[1] As mentioned on p. 24 (footnote) the "Dana" in 1924 found quite a small number of pelagic cod eggs on the east coast, so that some few cod and presumably only in certain years are able to shed their eggs on this cold coast during the summer (just as is the case with the plaice — TÅNING 1929, p. 13 f.).

Tabel 24. Frequency and size at each age. East Iceland. Nordfjord, 9.—12. July 1928.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
III	1925	44	10.8	37.8	32— 45
IV	1924	129	31.6	45.8	35— 58
V	1923	48	11.8	55.9	44— 70
VI	1922	144	35.3	67.1	50— 85
VII	1921	20	4.9	73.5	62— 88
VIII	1920	13	3.2	85.4	67—100
IX	1919	4	1.0	92.5	85— 98
X	1918	3	0.7	97.7	95—100
XI	1917	1	0.3	99.0	99
XII	1916	2	0.5	107.5	100—115
Total...	..	408	100.1	..	..

Tabel 25. Frequency and size at each age. East Iceland. Nordfjord. 13.—18. May 1929.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
III	1926	4	0.8	37.0	34— 39
IV	1925	40	7.8	45.7	40— 54
V	1924	190	37.2	54.7	42— 68
VI	1923	67	13.1	64.0	54— 74
VII	1922	59	11.5	73.1	59— 89
VIII	1921	37	7.2	81.6	66— 94
IX	1920	19	3.7	87.0	65— 99
X	1919	11	2.2	91.6	75—102
XI	1918	16	3.1	96.0	88—110
XII	1917	16	3.1	104.1	89—118
XIII	1916	10	2.0	102.9	90—117
XIV	1915	9	1.8	104.0	93—113
XV	1914	7	1.4	102.3	96—110
XVI +	1913÷	26	5.1	109.5	93—131
Total...	..	511	100	..	..

Tabel 26. Frequency and size at each age. East Iceland. Nordfjord. 1.—9. July 1930.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
III	1927	4	0.9	41.3	35— 44
IV	1926	18	3.9	45.6	35— 53
V	1925	39	8.5	54.7	44— 69
VI	1924	100	21.9	61.7	46— 82
VII	1923	33	7.2	74.2	62— 89
VIII	1922	234	51.2	81.7	62— 99
IX	1921	19	4.2	86.7	78— 96
X	1920	3	0.7	95.0	88—102
XI	1919	2	0.4	96.5	89—104
XII	1918	3	0.7	109.7	93—131
XIII	1917	1	0.2	101.0	101
XIV	1916	1	0.2	95.0	95
Total...	..	457	100	..	..

Whilst the curves for 1928 and 1929 probably give on the whole a good representation of the conditions at East Iceland, as known from earlier investigations, the 1930 curve shows that the small fish were not so dominant on the fishing grounds at the time of collection (July); in 1930 cod of 70—90 cm. were most prominent in the catches, that is, the 1922 year-class (see results of age analyses). The material of 1929 collected in May, as the curve of deviations from the three years' average shows, contains not only an excess of small fish but also one of larger cod of 90—120 cm.; in the first part of the season it is usual for these large fish to dominate the catches, as will be seen from the curves for 1928—30 showing the percentage proportions of small fish (p. 39); the 1929 curve shows, however, that large fish were more strongly represented that year than in the preceding or following year (April—May).

The measurement curves for 1928—30 show for this coast also that a collection taken in a part of the season can hardly be representative of the whole; in the beginning at any rate the normal changes in the sizes of the cod should as mentioned be followed throughout a whole season.

The age analysis has yielded the following results for East Iceland:

1928: both of the year-classes 1922 and 1924 are strongly represented (each with about 32—35 %); the 1924 class can be detected through a series of years on this part of the island (see p. 33).

1929: the year-class 1924 is dominant, whereas the 1922 class was but little prominent in May; whether the latter was more conspicuous in the catches in another part of the fishing season, is not known.

1930: the year-class 1922 dominates with 51 % of the catch; the 1924 class as in the preceding year is good (22 %).

b. Size and age.

The size and age of the East Iceland cod are discussed by Sæmundsson (1923, pp. 25—27); the material came from Nordfjord and was collected in the first half of August 1920; it consists chiefly of the age-groups II—V. Considering that the material was collected 1—3 months later than the 1928—1930 material discussed here, the agreement with regard to the average size of the age-groups is quite good; the III and IV-groups are a little smaller, the V, VI and VII-groups a little larger; the differences may be due to the difference in time and thus to migration and growth. From Fig. 3 p. 28 of Sæmundsson (1923) one can see, however, that the age-groups V, VI and VII are larger than the corresponding groups at North Iceland. As the growth is known to be slower on the east coast than on the north, we may assume that the average sizes given here p. 30 are the more correct; to judge from the curves (l. c. Fig. 3, p. 28) Sæmundsson's results may be considered too high. Taking the whole material as one, the growth on the east coast is distinctly less than on the north coast (Siglufjord).

The rather high average size of the older groups compared with that found on the north and north-west coasts may partly be ascribed to an immigration of spent individuals from the south coast, but this question has not been examined in detail.

We will shortly compare the size of the age-groups III—VIII as given in the following table.

Table 27. Length in cm. of the different age-groups. Eeast Iceland.

Age-group	III	IV	V	VI	VII	VIII
July 9th—12th 1928	37.8	45.8	55.9	67.1	73.5	(85.4)
May 13th—18th 1929	(37.0)	45.7	54.7	64.0	73.1	81.6
July 1st—9th 1930	(41.3)	(45.6)	54.7	61.7	74.2	81.7

(Averages from less than 20 spec. in brackets).

It will be noted that the differences in the average sizes for May and July are small in most cases, and they are certainly not of great significance and may probably be ascribed to chance. The small differences between May and July seem confusing at first glance, since one would expect a considerable increase in growth from the middle of May to the middle of July. At East Iceland, however, the summer does not reach its full effect in the sea until very late in the year, and the growth of the fish consequently begins very late in these cold waters. For this reason the figures given may be taken as approximately correct.

3. Supplementary samples from the east coast.

Of great importance for understanding the conditions prevailing on the east coast, and no less for a further insight into the question of the year-classes dominant for the moment at Iceland, is a small material collected by Dr. BJARNI SÆMUNDSSON onboard the trawler »Skallagrímur« while working on the south-east fishing banks out towards deep water in May 1930. As described by SÆMUNDSSON (1930) and LE GALL (1931) there is an extensive trawl fishery at this spot in the spring, for a great part of small fish.

The sample[1] from this part of Iceland gave the following result.

Tabel 28. Cod from the Hvalbaksgrunn (Hvalbakshalli), East Iceland. May 5th 1930. Depth: 150—275 metres.

Age-group	Year-class	Number of specimens	Percentage of the different age-groups	Average length in cms.	Range of variation (cm.)
IV	1926	1	0.5	46.0	46
V	1925	7	3.6	56.1	49—66
VI	1924	92	**47.9**	62.3	52—79
VII	1923	24	**12.5**	69.8	55—81
VIII	1922	54	**28.1**	77.0	64—93
IX	1921	10	5.2	84.9	78—98
X	1920	2	1,1	86.0	85—87
XI	1919	1	0.5	92.0	92
XII	1918	1	0.5	100.0	100
Total...	..	192	99.9	..	..

This sample, which was taken far out to sea on the outer edge of the banks, shows clearly, that the year-classes 1924 and 1922 were the dominant ones, but it also shows, contrary to what one would expect, that it was chiefly the younger class (1924) that was living out in the deep water at this time of year, whilst the older were searching after food nearer the land. Future investigations should concentrate attention on this distribution of the cod here on the east coast, where such large quantities of the cod taken later on the south coast grow up. The very large quantities of small cod which grow up on the banks, where the above sample was taken, have possibly not come as postlarvae round the north and north-east coasts, but directly from the south coast and the reason why they occur out here in great depths may conceivably be, that the coast here is blockaded by cold water till far on in the summer. Race investigations may help to throw light on this question.

With regard to the age and length of the cod out here, the sample displays the same slight growth as is known from other places at East Iceland; for the V—VI-groups the size is almost the same as at Nordfjord, but the size of the VII—IX-groups is less, presumably owing to migration of the larger cod.

A quite small sample of cod collected by Dr. BJARNI SÆMUNDSSON at Nordfjord (Nés)[2] on August 9th,

[1] See Fig. 2,b. Another sample from Litladjúp (also off East Icl.) is clearly of a similar kind, but cannot be used in this connection as the material is a selection of smaller cod (see SÆMUNDSSON in "Andvari" 1931, p. 82 f.). [2] See Fig. 2,c.

1930, indicates that the year-class 1922 had by that time given place to the 1924 class in great part; here as usual the cod decrease in size in the course of the season.

The sample had the following composition:

Table 29. Cod from Nordfjord 9. August 1930.

Age-group	III	IV	V	VI	VII	VIII	IX	Total
Year-class	1927	1926	1925	1924	1923	1922	1921	
Number.....	1	4	10	24	1	9	1	50
%	2.0	8.0	20.0	48.0	2.0	18.0	2.0	100.0
Aver. size in cm. ...	43.0	41.3	55.1	61.1	70.0	78.4	92.0	..

Section II.

General review and additional notes.

A. Results of collections previous to 1928.

In the foregoing we have dealt with the material from commercial catches for the years 1928—30. We have also some other collections, however, from the cruises of the research-vessel "Dana" to Iceland in the years 1924—27 and from the "Explorer" 1925, and we may just glance at these to see, whether the year-classes found dominant in our material were already more numerous than the other groups in the earlier collections, which consist mainly of the younger groups. We cannot enter here into a detailled discussion of the numerous samples, in some cases very large, in other small, but must be content with a bare summary. And in any case some of the material has already been dealt with by Johs. Schmidt (1926) and Árni Friðriksson (1929), to whose papers reference may be made for further information.

The accompanying Table (30) gives a view over the dominant year-classes on the different coasts of Iceland in the years 1924—27; the material consists of about 30 samples each containing some 50 to 600 age-determined specimens and was collected in very different ways, catches from the following apparatus being analysed as to age: eel-hand-seine, trawl, hand and long lines. Only the year-classes with a sufficient material are included; this excludes all the year-classes except those from 1919—26. The year-classes which are dominant in the catches, whether taken by eel seine, trawl or lines, are indicated by +; if some of the other groups exceed about $^1/_4$—$^1/_5$ of the total number of specimens age-determined, they are also indicated with +; where the groups are somewhat small but may be said to be of some importance when the material from all the apparatus is considered, they are denoted by ( ); ÷ indicates that a year-class, one would expect to find in the sample, is but weakly represented or absent.

Comparing this scheme with the graphs showing the frequencies of the age-groups in the years 1928—30 we find on the whole quite a good agreement; the scheme clearly indicates the 1922 group as the dominant in almost all the catches taken round Iceland, on the banks, in the fjords and bays, wherever this group could at all be expected in the samples, according to its age, the locality and apparatus used. The next group of importance is the year-class 1924, which appears to have been a good one, as we have noted in the 1928—30 material; it is numerous at any rate at East Iceland. The year-classes 1921, 1923 and 1925 are apparently of no great account, yet seem to be of some importance on the west and north coasts. The 1919 group could not be expected in very many samples; already in 1924 it could not be expected in several of the apparatus used or at the places frequented. The year-class 1920 must be regarded as bad. The 1926 group pos-

Table 30. Dominant year-classes in samples from the different coasts of Iceland 1924—1927.

Area	Samples caught in	Year-class							
		1926	1925	1924	1923	1922	1921	1920	1919
South Iceland	1924				..	..	..	..	..
	1925			+	÷	÷	..	..	..
	1926		..	..	..	..	..	..	..
	1927	+	÷	÷	÷	+	(+)	÷	+
West Iceland	1924				÷	+	(+)	(+)	÷
	1925			+	+	+	÷	÷	÷
	1926		(+)	+	+	÷	÷	..	..
	1927	+	..	..	÷	+	÷	÷	+
North-west Iceland	1924			*	..	+	+	÷	÷
	1925			+	+	+	+	÷	÷
	1926		..	..	+	+	+	÷	÷
	1927	..	..	+	÷	+	÷	÷	+
North Iceland	1924				..	+	+	÷	÷
	1925			(+)	+	+	(+)	÷	÷
	1926		÷	÷	(+)	+	(+)	(+)	..
	1927	..	÷	+	÷	÷	..	..	..
East Iceland	1924				(+)	+	÷	..	..
	1925			+	÷	+	+	÷	÷
	1926		÷	+	÷	÷	..	..	..
	1927	+	÷	+	÷	+	(+)	÷	..

* 0-group very abundant off the north-west coast in 1924.

sibly is of some dimensions, but has not appeared to any great extent in the 1930 commercial catches from north and east Iceland, where one might have expected to find it; on the other hand, it appears to be present in small quantities on the north-west coast.

Even if a year-class, e. g. 1924, seems from the method used to be present on all the coasts of the island, yet it has to be noted that the quantitative distribution points to an accumulation of this group on the east coast; other species (haddock, plaice) display the same phenomenon which may certainly be ascribed to the distribution of the pelagic fry by the currents in the year of production.

We have previously (p. 18) discussed some analyses of material from the coastal fishery on the western part of the south coast; the most prominent year-classes were those of 1913 and 1915, but the groups of 1911, 1912, 1914, 1916, 1917 and 1918 have apparently not been unimportant; we cannot go much farther than this, however, on the basis of the available material. The material collected in 1924 to 1927 has but few samples containing much of the groups hatched out in the years before 1919. One sample from the banks north-west of Iceland indicates, that the 1912, 1915 and 1917 groups (also 1919 and 1922) have been of some importance in any case at this part of Iceland. Sæmundsson's material (1923) goes to show, that not a few of the year-classes in the period 1910—1920 have been represented in a satisfactory manner (e. g. 1913 as well as 1912), but it is impossible from his material, which was collected with a different object in view, to form an adequate estimate of the year-classes which were of most importance for the fishery during the period under consideration.

B. General review of the fluctuations in 1928—30.

The experience gained from a study of the fluctuations of the stock of cod at Iceland provides encouragement for a continuation, but future investigations will have to consider various changes and extensions of the collections, which the preparatory investigations have made desirable or necessary.

It seems clear, however, that results of no little importance may be obtained by arranging the work in a similar manner as in 1928—30; from observations on the commercial catches from the north-west, north and east coasts it should be possible some years in advance, to foretell whether a series of good or moderate year-classes are to be expected at the places where the major fishery is carried on, namely, at the spawning grounds in the south and west.

We may here summarize in the first place the conditions on the coasts where the growth of the cod mainly takes place, and then the conditions at the spawning places of the south coast during the three years.

The conditions with regard to the stock of growing cod, so far as we can gather from the available material, are displayed in the figures p. 12—13.

N.W.—N.—E. Iceland 1928: The 1922 year-class is dominant in the N.W., N. and E.; the 1921 group is also of importance in the N.W. and N.; the 1923 group likewise in the N.W.; and the 1924 group strong in the E.

1929: the 1922 group is this year not so numerous at the times and places where the material was collected. In the N.W., however, it was abundant in the catches early in May (ca. 50 %) but disappeared then, and the 1923—25 groups were of more importance. In the N. the 1922 group was abundant in the early summer, but had left the area in July and its place was taken by the 1924—26 groups. Towards the east the 1924 group dominated, whilst the 1922 group was of no importance in the material collected.

1930: the 1922 year-class was absolutely dominant N.W., N. and E.; the 1924 group was strong in the east.

Taken altogether, there can thus be no doubt that the 1922 group was specially dominant on the N.W., N. and E. coasts where it grew up; whether it was possibly more numerous on one of the coasts or evenly distributed, cannot be determined from the material available. As we have seen, the 1922 group was spotted as a good year-class right from 1924, when the investigations in these waters were renewed after the war.

Considering now the conditions on the spawning grounds of the cod at Iceland we cannot fail to remark, that quite different year-classes are present in the catches there to begin with, and that the 1922 group first appeared in enormous numbers in 1930 as 8 year-old mature fish.

S. Iceland 1928: the 1919 year-class is dominant; the 1917, 1918 and 1920 groups are of some importance.

1929: 1919 group again dominant; the year-classes older than 1917 right back to 1913 and older are of no small importance (up to ca. 15 % for some year-classes).

1930: the 1922 group is absolutely dominant; of the other groups 1919 is the strongest.

The 1922 group thus appears in great force on the spawning grounds as 8 year-old fish; but even in 1930 there were still large reserves of this group on the other coasts where in spite of their considerable age they had not yet become mature.

A comparison with the fluctuations in other parts of the North Atlantic where the cod is distributed will certainly in time bring a much better understanding of this question, so important for the fisheries. According to the available data (from Oscar Sund and from Ad. S. Jensen and Paul M. Hansen (1931)) we

have the following summary indicating the specially good groups of recent years; the Norwegian determinations, however, are more exact than those for the other regions.

Table 31. Dominant year-classes at Norway, Iceland and Greenland.

Area	Dominant year-classes											
Norway	..	1912	..	..	1915	..	1917	..	1919	..	..	(1922)*
Iceland	(?)	1912	1913	(?)	1915	(?)	1917	(?)	1919	..	..	1922
Greenland	..	1912	..	..	..	..	1917	..	..	..	..	1922

* Cf. SUND: Der Fischerboote, 1/8 1931, p. 250.

There is a certain amount of agreement between Iceland and Norway, but it is likewise obvious that Greenland seems to differ somewhat from the two easterly regions, since at least two of the good year-classes for Iceland appear to be wanting or of minor importance at Greenland in the years of observations. (From the American side we have no information regarding the year-classes which have been dominant during the period mentioned).

C. Size and age.

To provide a basis for future investigations of the changes in the stock by means of measurements we have endeavoured in the foregoing pages to give a summary of the size and age of the cod within the regions investigated, in as much detail as the scope of the present work will permit. SÆMUNDSSON (1923) has already indicated the main features of the growth on the different coasts of Iceland.

In the accompanying summary (Table 32) South Iceland is naturally taken by itself, to show the contrast from the other coasts; the stock of cod at South Iceland (at any rate for the area discussed in this work) consists of spawning cod, whereas the cod of the other coasts are for the most part growing fish. Since we can distinguish these two categories of cod at Iceland as at Norway, it seems appropriate for the sake of com-

Table 32. Average length of cod of different ages, in cm.

Age in years	Iceland[1]		Norway[2]		W. Greenland[3]
	South-Icl.	E.,N.&N.W.-Icl.	"Skrei"	"Loddetorsk"	All cod
1	..	..	..	..	16.4
2	..	..	..	..	26.2
3	..	37.0— 43.2	..	..	41.9
4	..	45.6— 51.5	..	44.2	53.8
5	..	54.0— 65.1	..	50.3	66.1
6	72.0— 83.1	61.7— 73.8	..	58.3	74.3
7	79.3— 92.5	68.8— 80.2	74.7	61.8	79.6
8	83.5— 92.8	75.9— 89.6	79.5	67.5	86.4
9	91.7— 95.5	86.7— 96.6	84.0	75.1	90.9
10	94.0— 98.9	89.0—107.0	86.2	79.0	96.6
11	97.1—101.5	89.0—108.3	88.4	83.4	101.1
12	99.9—102.6	..	89.6	..	107.3
13	98.3—104.9	..	92.0	..	110.1
14	101.0—107.5	..	..	..	116.7
15	102.4—112.3	..	..	..	119.7

[1] Outer limits of average in samples from the years 1928—30. For S. Iceland only the average values for the line-caught fish have been used, the nets-caught fish being omitted.

[2] From SUND, 1930, p. 10.

[3] From JENSEN and HANSEN, 1931, p. 18.

parison to include the sizes given by SUND for the Norwegian "Skrei" and "Loddetorsk" (1930). We add also the average size of the different age-groups of the Greenland cod (AD. S. JENSEN and PAUL M. HANSEN 1931).

We see that the growth of the cod at Iceland fluctuates between very low and very high values (according to the locality); within the three regions mentioned for the occurrence of the cod in northern seas the growth is on the whole greatest on the coasts of Iceland washed by the warmer waters. The species appears to live under the best conditions for its welfare on the warm south-west coast of Iceland and we obtain the impression, from a study of its growth and the fluctuations in its stock, that quite extraordinary changes must take place in the natural conditions over a number of years, to effect any appreciable change in the size of the stock.

D. Numerical proportion of sexes.

In the foregoing pages we have at times touched upon the relative proportions of the sexes; in interpreting the measurement curves it may be of importance to know, whether the slightly larger females are in the majority or otherwise relative to the slightly smaller males. SÆMUNDSSON (1923, p. 23) has given a summary of the sex differences in regard to size in cod from the different coasts of Iceland; our own observations are on the whole in agreement with his.

The accompanying Table 33 will give some idea of the distribution of the sexes on the different coasts in the years mentioned. Of special interest are the conditions on the spawning grounds at the Westmanna Islands. We find here an extremely small proportion of females in 1928 and still fewer in 1929; in the first part of the season, however, the percentage has certainly been somewhat higher. The increase in the percentage of females in 1930 is very obvious and we now know the reason, as the age-analyses from round the island show, that the year-class 1922 was of enormous dimensions everywhere but only appeared for the first time on the spawning grounds in 1930 and then in very large numbers. As we know, at least for North and East Iceland, that males and females are almost equally represented among immature fish whilst the females are in the majority on the whole among the larger cod, it is obvious that a new and dominant year-class making its appearance on the spawning grounds will raise the percentage of females considerably. A decline of the female percentage, such as we find from 1928—29, will thus be typical always for the spawning grounds here when an abundant year-class is on the ebb with no specially large group present to take its place (see Fig. 10).

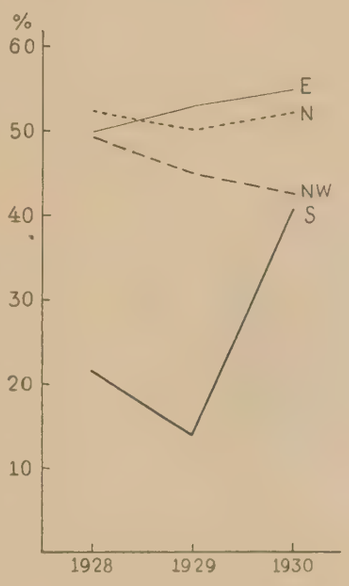

Fig. 10. Percentage of females. Iceland 1928—30 (commercial catches). E East Iceland, N North Iceland, NW North-west Iceland, S South Iceland.

With regard to the low percentage of females at North-West Iceland and its decrease during the three years, the best explanation seems to be, on the one hand, that some spawning takes place on the northern part of the west coast and, on the other, that more females than males of the year-class 1922 have left that area.

The data for North and East Iceland, where the stock consists of immature cod with a sprinkling of wandering spent cod, show that males and females are present in almost the same amounts; as explained on p. 28, however, the slightly higher number of females over males comes from the immigration of old, large females. To obtain a reliable insight into these conditions, however, we require observations over a longer series of years.

Table 33. Numerical proportion of sexes (commercial catches).

Locality	Year	Total sex determined	♀♀	♂♂	% of ♀♀	% ♀♀ < 85 cm.
South Iceland: Westmanna Isls.	1928	2,268	493	1,775	21.7	(28.1)*
	1929	3,634	514	3,120	14.1	(13.7)*
	1930	3,562	1,445	2,117	40.6	42.5
	1928—30	**9,464**	**2,452**	**7,012**	**25.9**	**41.0**
North-West Iceland: Isafjord	1928	2,454	1,205	1,249	49.1	47.9
	1929	2,714	1,220	1,494	45.0	43.4
	1930	4,932	2,092	2,840	42.4	40.9
	1928—30	**10,100**	**4,517**	**5,583**	**44.7**	**43.2**
North Iceland: Siglufjord	1928	6,642	3,468	3,174	52.2	49.6
	1929	4,543	2,278	2,265	50.1	48.2
	1930	6,028	3,142	2,886	52.1	49.1
	1928—30	**17,213**	**8,888**	**8,325**	**51.6**	**49.0**
East Iceland: Nordfjord	1928	3,469	1,728	1,741	49.8	49.1
	1929	4,190	2,215	1,975	52.9	50.2
	1930	4,693	2,577	2,116	54.9	50.6
	1928—30	**12,352**	**6,520**	**5,832**	**52.8**	**51.1**

* From the Westmanna Islands area only a small material of cod smaller than 85 cm. available.

Section III.

Evidence of dominant year-classes in the fisheries statistics.

To investigate the possibility of dertermining from the available statistics regarding the Icelandic fisheries, whether the dominant year-classes of recent years make themselves evident in the size of the catches, we may examine here the data for Iceland and England. For Iceland the statistics give the landings on each of the four coasts[1]; even if a portion of the fish taken on one of the coasts is included in the returns of another, where it is landed, yet the Icelandic statistics furnish a fair estimate of the fisheries on the different coasts. The English statistics on the other hand only give the totals for the whole Icelandic region. It would be of great use if we could manage to divide up the fishing grounds in the statistics, so as to show, for example, the magnitude of the catches from the chief spawning places (e. g. from Ingolfshöfdi on the south coast up to Bredebugt on the west coast) and from the areas which the growing cod frequent in their food wanderings (i. e. the other parts of the Icelandic coasts). In the Icelandic statistics also it would be useful if some measure of the intensity of fishing could be added, for example, catch per man per day as used by Sund in Norway, or some other measure (e. g. number of cod per 1000 hooks and catch per 100 hours' trawling as in the English statistics of recent years). So long as complete statistical information is lacking, one is unable to make a satisfactory estimate of the importance for the fishery of the dominance or the reverse of the separate year-classes, such as we have found in the scientific material collected for the purpose of tracing the fluctuations in the separate year-classes. The Icelandic fisheries statistics have, however, been greatly improved in recent years, especially through Kristján Bergsson's interest in the matter.

In Table 34 we give a summary of the yield of the Icelandic fisheries in the years 1926—30 (in Skippund of dried fish); a distinction is made (in %) between large and small cod landed on the different coasts. The steady increase in the yield is certainly due, not only to a greater intensity of fishing but also to the stock

[1] See "Ægir" 1926—1930.

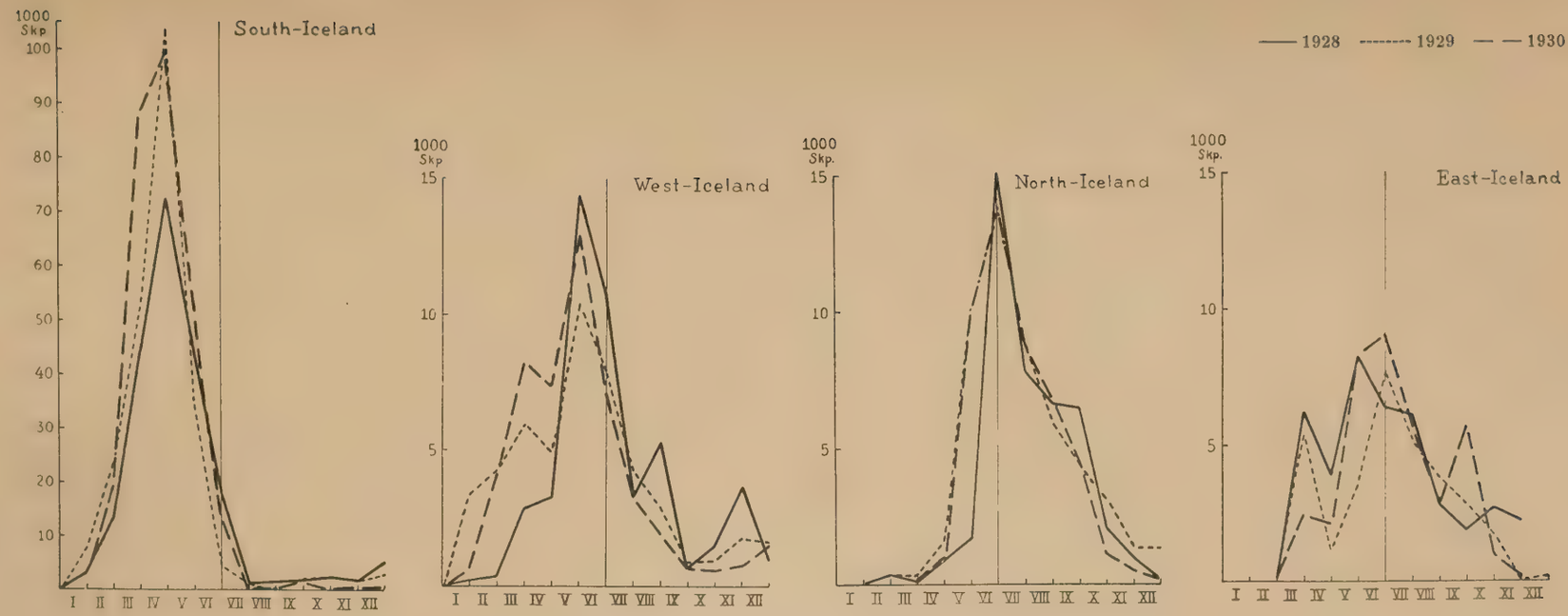

Fig. 11. Icelandic Cod fishery. Catch per month in Skippund à 160 kg (split cod); 1928—1930.

Fig. 12. Icelandic Cod fishery. Percentage of small cod per each months catch; 1928—1988.

being larger as the result of a favourable period for its growth and maintenance. An increase in the percentage of small fish in the catches may certainly be ascribed to specially good year-classes. We see for instance that the year 1927 gives larger catches of small fish than the preceding year corresponding with the appearance of the year-class 1922 (the V-group) in the catches.

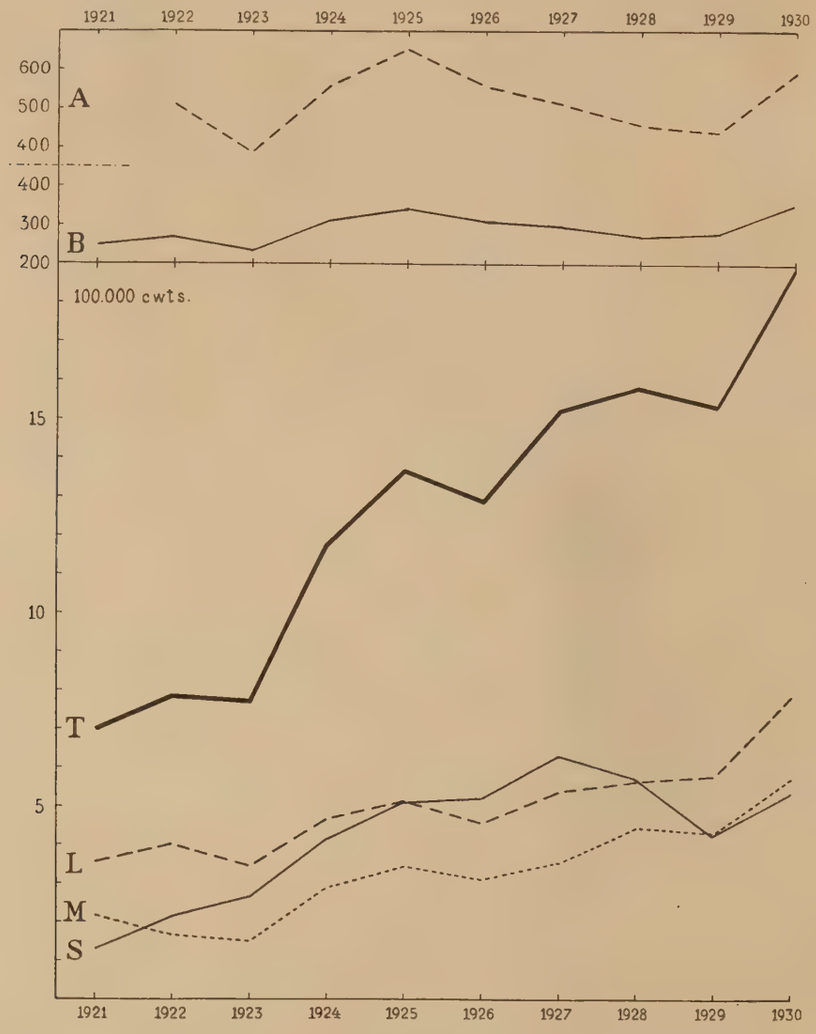

Fig. 13. Quantity and average catch of cod from English Steam Trawlers 1921—1930.

A. The average catch per 100 hours fishing in cwts. — B. The average catch per day's absence from port in tenths of a cwt. — T. Quantity of cod landed from Iceland, in 100.000 cwts. L large cod, M medium cod, S small cod.

Table 34. Catch of cod (split cod) in 1000 Skippund (à 160 kg) landed in Iceland. In parenthesis percentage of codling of catch.

Area	1926	1927	1928	1929	1930
South-Iceland	**141** (17)	**189** (21)	**209** (18)	**236** (10)	**278** (18)
West-Iceland.....	**36** (44)	**38** (63)	**48** (55)	**49** (47)	**49** (41)
North-Iceland	**15** (23)	**27** (44)	**42** (43)	**51** (41)	**47** (38)
East-Iceland	**32** (34)	**27** (41)	**41** (44)	**32** (47)	**37** (43)
Total...	**225** (24)	**281** (31)	**340** (29)	**368** (23)	**412** (25)

The curves Figs. 11—12 give for the four coasts the size of the catches in Skippund (of 160 kg. each) and also the percentage of small cod in the total catch throughout the whole season for the years 1928—30. From these we obtain a picture of the progress of the fishery on the different coasts as also of the changes in the relative quantities of small and large cod. This is of interest in permitting us to see, whether the collections made to determine the fluctuations in the year-classes, discussed in the foregoing pages, are adequate or not. We have several times referred to these curves in earlier pages.

From the English fisheries statistics we have taken the material for the years 1921 to 1930 in the preparation of the curves Fig. 13. As in the Icelandic statistics the total catch shows a steady increase, presumably not altogether from a more intensive fishery but because there seem to have been more fish in the sea than usual; this is indicated by the curves for the average catch per day's absence from port and average catch per 100 hours' trawling.

Whilst the curves for medium and large cod accompany one another fairly well, the curve for small cod shows a sharp rise, and this may be ascribed to the appearance of the dominant year-classes (1917, 1919 and 1922; perhaps also 1924). In the curves for the average catch the rise about 1924—25 came most probably from the good year-classes 1917 and 1919, whilst the rise in 1930 must be ascribed to the year-class 1922 from all we know of that year's dominance.

In 1930 the 1922 year-class appeared in very great force as 8 years old on the spawning grounds (see p. 14); we do not yet know whether this always is the normal age for a year-class to appear in large quantities on the spawning grounds. If this proves to be the case, it will be of the greatest assistance in forecasting the coming of good fishing on this part of the coast, that is for about $^2/_3$ rds of the whole Icelandic fishery. The curves from the English statistics, however, do not support this standpoint altogether; if we take the year-classes 1915, 1917, 1919 and 1922 as being the best of recent years, the curves should indicate ascents in the years 1923, 1925, 1927 and 1930 so far as the average catches are concerned. This holds good for the years 1925 and 1930, but not for the other two. This may be due to an error in our judgment of the age of cod at first maturity and of the magnitude of the 1915 and 1919 groups, but may also be due naturally to other factors affecting the appearance and yield of these year-classes (e. g. hydrographical and meteorological conditions).

Tables of Measurements.

1. Westmanna Isls., South Iceland.

5-cm. groups	1928		1929		1930	
	No.	‰	No.	‰	No.	‰
145—149	1	0.4	..	..	..	..
140—144	..	..	..	..	..	..
135—139	..	..	1	0.3	1	0.3
130—134	1	0.4	1	0.3	..	..
125—129	1	0.4	4	1.1	2	0.6
120—124	4	1.4	13	3.6	6	1.7
115—119	29	10.2	59	16.2	19	5.3
110—114	102	35.9	218	60.0	57	16.0
105—109	301	106.1	523	144.0	140	39.3
100—104	694	244.5	879	241.9	309	86.8
95— 99	883	311.1	925	254.5	580	162.8
90— 94	599	211.1	621	170.9	877	246.2
85— 89	183	64.5	280	77.1	764	214.5
80— 84	34	12.0	105	28.9	505	141.8
75— 79	6	2.1	25	6.9	200	56.2
70— 74	..	..	8	2.2	85	23.9
65— 69	..	..	2	0.6	12	3.4
60— 64	..	..	..	..	5	1.4
Total number measured	2838	..	3634	..	3562	..

2. Isafjord, North-west Iceland.

5-cm. groups	1928		1929		1930	
	No.	‰	No.	‰	No.	‰
135—139	..	..	1	0.3	1	0.2
130—134	..	..	5	1.5	2	0.4
125—129	..	..	3	0.9	2	0.4
120—124	4	0.9	5	1.5	5	0.9
115—119	7	1.6	6	1.8	6	1.1
110—114	9	2.1	15	4.6	19	3.4
105—109	23	5.4	25	7.7	23	4.1
100—104	42	9.8	31	9.5	39	7.0
95— 99	37	8.6	30	9.2	59	10.6
90— 94	64	14.9	61	19.4	129	23.2
85— 89	121	28.2	109	33.5	229	41.2
80— 84	334	77.7	231	71.0	449	80.7
75— 79	705	164.0	336	103.3	626	112.6
70— 74	834	194.0	377	115.9	780	140.2
65— 69	668	155.4	364	111.9	709	127.5
60— 64	533	124.0	396	121.7	601	108.1
55— 59	356	82.8	420	129.1	527	94.8
50— 54	245	57.0	306	94.1	409	73.5
45— 49	139	32.3	233	71.6	340	61.1
40— 44	99	23.0	201	61.8	337	60.6
35— 39	61	14.2	76	23.4	207	37.2
30— 34	17	4.0	21	6.5	56	10.1
25— 29	1	0.2	1	0.3	7	1.3
Total number measured	4299	..	3253	..	5562	..

3. Siglufjord, North Iceland.

5-cm. groups	1928		1929		1930	
	No.	‰	No.	‰	No.	‰
135—139	1	0.2	..	..	2	0.3
130—134	..	..	..	..	2	0.3
125—129	4	0.6	3	0.7	2	0.3
120—124	13	2.0	13	2.9	5	0.7
115—119	39	5.9	28	6.2	4	0.5
110—114	83	12.5	26	5.7	25	3.4
105—109	141	21.2	43	9.5	37	5.0
100—104	210	31.6	57	12.6	56	7.5
95— 99	204	30.7	61	13.4	139	18.7
90— 94	247	37.2	102	22.5	363	48.7
85— 89	360	54.2	198	43.6	744	99.9
80— 84	755	113.7	375	82.5	1547	207.7
75— 79	1229	185.0	453	99.7	1865	250.3
70— 74	1240	186.7	340	74.8	1237	166.0
65— 69	691	104.0	242	53.3	597	80.1
60— 64	359	54.1	315	69.3	251	33.7
55— 59	308	46.4	506	111.4	155	20.8
50— 54	341	51.3	569	125.3	117	15.7
45— 49	256	38.5	522	114.9	125	16.8
40— 44	136	20.5	427	94.0	135	18.1
35— 39	23	3.5	223	49.1	35	4.7
30— 34	2	0.3	36	7.9	6	0.8
25— 29	..	..	4	0.9	1	0.1
Total number measured	6642	..	4543	..	7450	..

4. Nordfjord, East Iceland.

5-cm. groups	1928		1929		1930	
	No.	‰	No.	‰	No.	‰
145—149	..	..	..	..	1	0.2
140—144	1	0.2	..	..	1	0.2
135—139	2	0.3	1	0.2	1	0.2
130—134	5	0.8	5	1.2	..	..
125—129	6	1.0	5	1.2	3	0.5
120—124	12	2.0	8	1.9	5	0.8
115—119	17	2.8	40	9.6	7	1.1
110—114	32	5.3	136	32.5	13	2.0
105—109	62	10.3	169	40.3	32	5.0
100—104	81	13.4	164	39.1	48	7.5
95— 99	74	12.2	181	43.2	154	24.0
90— 94	65	10.7	152	36.3	397	61.8
85— 89	99	16.4	162	38.7	834	129.9
80— 84	135	22.3	167	39.9	1222	190.3
75— 79	276	45.6	249	59.4	1112	173.2
70— 74	526	86.9	279	66.6	615	95.8
65— 69	664	109.8	265	63.3	407	63.4
60— 64	602	99.5	335	80.0	384	59.8
55— 59	467	77.2	601	143.4	368	57.3
50— 54	618	102.2	617	147.3	282	43.9
45— 49	894	147.8	409	97.6	208	32.4
40— 44	887	146.6	169	40.3	191	29.7
35— 39	452	74.7	64	15.3	119	18.5
30— 34	67	11.1	12	2.9	16	2.5
25— 29	6	1.0	..	..	1	0.2
Total number measured	6050	..	4190	..	6422	..

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